APPENDIX E

RISK ASSESSMENT

US Army Corps of Engineers
Buffalo District

CONTAMINANT MONITORING ASSESSMENT
LORAIN HARBOR
CONFINED DISPOSAL FACILITY
LORAIN, OHIO

June 2007

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EXECUTIVE SUMMARY

This contaminant monitoring assessment was completed in order to determine whether or not further management actions need to be taken at the dredged material confined disposal facilities (CDFs) under the jurisdiction of the Buffalo District of the US Army Corps of Engineers, in order to ensure protection of human health and the environment. This report followed guidance contained in the *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual* (UTM) (USACE 2003). The guidance contained within the UTM is technical and not regulatory in nature. It should be noted that the use of threshold levels such as criteria, guidelines, risk-based screening levels, etc. should not be mistaken for regulatory standards. This evaluation followed a tiered approach. Two tiers of evaluation were completed and are presented in this report. Based on this evaluation, it was determined that management actions are not necessary because contaminants in CDF dredged material are not migrating into the environment outside the facility at levels that would pose a risk to human health or the environment.

The first Tier involved using a risk-based approach, in which potential contaminant migration pathways were identified. The migration pathways are routes by which contaminants or constituents of potential concern associated with dredged material contained in CDFs may move from the dredged material within the site into the environment outside the facility (USACE 2003). Secondly, environmental or human receptors outside of the CDF were identified. These receptors have the potential to be exposed to contaminants associated with the dredged material from within the CDF, once the contaminants migrate outside the facility. Thirdly, risk-based screening levels were identified that protected the identified receptors that could be exposed via the identified migration pathways. The levels of constituents measured in the dredged material were compared to the risk-based criteria in this Tier I evaluation.

This Tier I evaluation concluded that there is enough information to dismiss from further concern, most of the contaminants in the CDF. However, there was not enough evidence to eliminate the potentially complete pathway of bioaccumulation of PAHs and cadmium to terrestrial organisms (birds and mammals) who visit the site. In addition, cadmium may have the potential to accumulate in vegetation, once it becomes established on the CDF in the future.

These pathways and constituents were carried forward to a Tier III evaluation, i.e., plant and earthworm bioassays were conducted on Lorain Harbor dredged material and compared to the Monkey Island Reference soil. Plant uptake of metals by *Cyperus esculentus* grown in dredged material from the Lorain Harbor CDF was not statistically higher than uptake from the Monkey Island Reference. Earthworms exposed to Lorain Harbor dredged material and Monkey Island Reference soil were analyzed for PAHs. Uptake of three PAH compounds were detected in earthworms exposed to Lorain Harbor CDF material, and none were detected in the earthworms

exposed to Monkey Island soil. There are no existing threshold criteria for PAH concentrations in earthworm tissues. However, calculated acceptable PAH compound concentrations in earthworms that would be ingested by mammals indicated that the risk posed by those experimentally bioaccumulated by earthworms from the CDF material would be insignificant.

Based on the results of this evaluation it is recommended that beneficial uses of the CDF could include park or other recreational use. If fertilizer application is planned in the future as part of park or recreational use, it may be necessary to monitor fertilizer use and pH to maintain pH levels above 6.5 to minimize availability of metals.

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ABBREVIATIONS AND ACRONYMS

BEHP	Bis(2-ethylhexyl)phthalate
BNAs	Base neutral and acid extractable compounds
CAA	Clean Air Act
CCC	Criteria Continuous Concentration
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMC	Criteria Maximum Concentration
COC	Constituent of Concern
DDT	Dichlorodiphyenyltrichloroethane
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
HTRW	Hazardous, Toxicological, Radiological Waste Sites
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFTA	Niagara Frontier Transportation Authority
NYSDEC	New York State Department of Environmental Conservation
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PEC	Probable Effects Concentrations
PL	Public Law
PPL	Priority Pollutant List
PRG	Preliminary Remediation Goal
SERA	Screening Ecological Risk Analysis
TEC	Threshold Effects Concentrations
TOC	Total Organic Carbon
UTM	Upland Confined Disposal Facilities – Testing Manual
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOCs	Volatile Organic Compounds

1. INTRODUCTION

1.1 Objective

The objective of this evaluation is to determine whether or not further management actions need to be taken at the dredged material confined disposal facilities (CDFs) under the jurisdiction of the Buffalo District of the US Army Corps of Engineers (USACE), in order to ensure protection of human health and the environment. Management actions would be recommended if it is determined that contaminants are migrating from dredged material within the CDF into the environment outside the facility at levels that would pose a risk to human health or the environment. This report followed guidance contained in the *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual* (UTM), and follows a risk-based approach (USACE 2003). The guidance contained within the UTM is technical and not regulatory in nature. It should be noted that the use of threshold levels such as criteria, guidelines, risk-based screening levels, etc. should not be mistaken for regulatory standards. This evaluation followed a tiered approach. The first tier is presented in this report. Subsequent tiers of evaluation may be needed.

1.2 History

Commercial navigation is a critical element of the national economy. Shipping channels and harbors require periodic dredging to maintain required depths. The USACE dredges, relocates, and disposes of hundreds of millions of cubic yards of sediment annually. Over one hundred harbors and channels are presently maintained in the U.S. Great Lakes by the USACE, including several areas that the International Joint Commission has described as Areas of Concern due to, among other factors, contaminated sediments. The fate of these contaminated sediments has been a public health issue because of potential human exposure or contamination of biota.

Section 123 of Public Law (PL) 91-611 (1970) authorized the USACE to construct, operate, and maintain confined disposal facilities (CDFs) in Great Lakes harbors where dredged materials have been deemed to be unsuitable for open-lake disposal. A CDF is an engineered structure consisting of dikes or other structures that extend above any adjacent water surface and enclose a disposal area for containment of dredged material, isolating the dredged material from adjacent waters or land (USACE and USEPA 1992). Of the approximately four million cubic yards of sediments dredged annually from Federal navigation projects in the Great Lakes, about half are placed into existing CDFs. Disposal of dredged material in CDFs is one of the most commonly considered alternatives for such material. CDFs are also an option considered for disposal of contaminated sediments dredged for purposes of sediment remediation. They are used as temporary rehandling sites or for final disposal. CDFs are also used for the disposal of clean sediments where other disposal options are too costly or present additional environmental problems (USACE 2003).

Figure 1 illustrates the various categories of CDFs. CDFs may be constructed as upland sites, nearshore sites (partial on-shore/off-shore design), or as island containment areas (Figure 1). CDFs vary considerably in size, dike design, and method of filling. CDFs are typically designed to retain solids while allowing water to be released through an overflow-weir, and/or through semi-permeable dikes. CDFs are not solid waste landfills. They are designed and constructed specifically for disposal of dredged sediment, which has a high water content, and to return the flow of excess water as effluent to surface waters (USACE 2003). Over 30 CDFs now exist in the U.S. Great Lakes with over twenty-five of these having been constructed with Federal funds.

CDFs constructed in water may become upland sites once the fill reaches elevations above the mean high water elevation. A true nearshore site will take advantage of the shoreline as a part of the containment structure for the site, with in-water dikes or other containment structures required only for the outer walls of the total enclosure. Island CDFs are similar to nearshore CDFs, except that they are constructed totally in water with no direct physical connection to the shore (USACE 2003).

Depending mostly on the elevation and frequency of dredged material disposal, dredged material in CDFs may develop to support aquatic, wetland or terrestrial-type habitats. A particular CDF may evolve through a succession of habitat types during its life. As sites are filled, aquatic habitat may be replaced by wetland and then terrestrial habitat. At any point in time, the portions of a single CDF near the inflow point may exhibit terrestrial habitat characteristics, which may shift to wetland habitat and then to aquatic habitat near the weir (USACE 2003).

A primary concern with CDFs is the potential for release of contaminants incorporated within the dredged material back into the environment. Potential pathways for contaminant release from CDFs include migration through or under the dikes, volatilization to the atmosphere, release with discharge water via the weir, and uptake by animals living or feeding in the facility. The purpose of this document is to evaluate the potential release pathways and to assess associated environmental and human health risks.

1.3 Dredged Material Management

The transport of dredged material to the CDF may be accomplished by hydraulic or mechanical means. Hydraulically dredged sediments may be conveyed to the facility with a pipeline from the hopper or cutterhead. Mechanically dredged sediments may be transported to the facility and offloaded mechanically from a barge, or the sediments may be converted to a slurry for hydraulic transfer to the facility via pipeline.

Typically, CDFs are constructed with a designated off-loading site. With mechanically placed material, dredged sediment tends to accumulate near the offloading site. If the CDF is filled hydraulically, the discharge of the dredge slurry into the site is generally located away from the overflow weir and a sufficient amount of retention time allows for solids to settle, which translates into an acceptable effluent discharge. If the CDF is filled mechanically, the sediment is physically lifted and placed into the facility using a crane and clamshell bucket.

Early CDFs were designed to retain only solids and were not designed to be watertight. In some instances they were designed to be semi-permeable. CDFs were often constructed with gradations of stone in the dike walls. The outer face of the dike walls were required to have heavy armor stone to withstand forces created by wave action encountered on the Great Lakes. The interior face of the dike walls would also require some armoring to withstand wave action generated from the water body within the CDF. Various designs were used, including gradations of smaller stone that allow water to move through the dike but trap fine sediment. The fine sediment would presumably clog the dike as the CDF was filled, preventing further release of water through the dike.

USACE policy regarding the flow of CDF return water through the overflow weir into nearby surface waters is that it is a discharge regulated under Section 404(b)(1) of the Clean Water Act. This mandates that unacceptable adverse effects on the aquatic environment be avoided during in-water disposal of dredged material. Therefore, a point source discharge permit under Section 402 of the Clean Water Act, called a National Pollutant Discharge Elimination System (NPDES) permit, is not required.

2. POLLUTANTS

Soil and water samples from the Lorain Harbor CDF were collected to evaluate the potential for release of contaminants associated with the dredged material back into the environment. No sediment samples were collected since the CDF is filled to near capacity and there are no open areas within the dike. To simulate potential sediment contaminant concentrations, soil samples were collected and submitted to the laboratory for leachate analysis.

Generally, pollutants in Great Lakes dredged material may be divided into three main categories: chlorinated organic compounds (pesticides/polychlorinated biphenyls [PCBs], and dioxin), polycyclic aromatic hydrocarbons (PAHs), and heavy metals. Volatile organic compounds (VOCs) have also been detected in Great Lakes dredged materials, however, to a lesser extent than the three categories cited above. While other physical and chemical constituents are important to water quality in the Great Lakes, these pollutants are not as critical when evaluating dredged material being placed in a CDF. Samples were analyzed for one or more parameter groups from the Federal Priority Pollutant List (PPL, Section 307 of the Clean Water Act) to ensure that the three major groups of pollutants were comprehensively investigated. The PPL includes 129 compounds/analytes analyzed as volatiles, semi-volatiles, pesticides/PCBs, heavy metals, and cyanide. PAHs are a sub-parameter group of the PPL semi-volatile group. The following discusses the most likely PPL compounds/analytes to be detected in material that is dredged from the Great Lakes watershed.

2.1 VOCs

VOCs in general are organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform. The loss of VOCs from sediments and dredged materials is a recognized environmental problem, and disposal and storage operations associated with dredged material placement in CDFs can result in VOC emissions.

Contaminant chemical properties such as Henry's Law Constant and vapor pressure are also very important in determining contaminant flux to air. Henry's Law states that chemicals with higher vapor pressures and low aqueous solubilities will tend to volatilize while chemicals with lower vapor pressures and higher aqueous solubilities will tend to dissolve in water. Environmental variables such as relative air humidity and temperature can also play a part in contributing to

VOC loss. Volatile emissions pathways from CDFs can include releases from plant covered dredged material, exposed dredged material, ponded water, and from effluent released from the CDF.

The highest volatile contaminant transfer conditions are in the first few hours after the surface of the dredged material is exposed. After the initial drying of the surface occurs, the rate of volatile contaminant transfer is reduced to levels less than that for a ponded condition. Since ponded conditions can remain over dredged material in a CDF for considerable periods, the ponded condition is likely the most critical at most sites. Contaminant transport from in situ dredged material to air is a relatively slow process because most contaminant should first be released to the water phase prior to reaching the air.

Currently, there are no known instances where volatiles from CDFs have posed a potential release sufficient enough to trigger the regulatory application of the Clean Air Act (CAA). Importantly, the CAA regulates volatile emissions from a point source (stack), and the CAA regulates only a few parameters such as particulates and carbon dioxide. Neither of these scenarios applies to CDFs. Nevertheless, there are occasions where workers can be exposed to volatile emissions while undertaking management actions at the CDF such as dike rehabilitation and dewatering activities.

2.2 Chlorinated Organic Compounds

2.2.1 PCBs

PCBs are mixtures of chlorine substituted biphenyl compounds. The structure of the compound consists of a biphenyl molecule with substitution of chlorine for the hydrogen on one to ten of the positions on the ring. Differing amounts of substitution and different positions of the chlorines leads to 209 possible compounds, termed congeners. If only the empirical formula is evaluated, the PCBs may be subdivided into ten PCB homologues. The different degrees of chlorination are noted by four-digit numbers after the trade name Aroclor, such as Aroclor 1242 or Aroclor 1260. With the exception of Aroclor 1016 (which is 41% chlorine), the last two digits of the four-digit term represent the percentage of chlorination by mass of the PCB mixtures. Homologous PCBs that only differ by position of the chlorine molecules are termed isomers.

PCBs in the aqueous phase may be sorbed to sediments or may be released to the atmosphere, depending on solubility, vapor pressure, mass transfer coefficients, and other congener specific characteristics. Solubility of PCBs is exceptionally low and this low aqueous solubility results in high partitioning coefficients to abiotic and biotic particles in sediments. Sorption is determined by the organic carbon content of the particles with the highest concentrations bound to organic carbon-rich, clay size particles (Eisenreich et al., 1989).

PCBs in soils will volatilize out of the soil depending on several properties, such as the organic content of the soil and nature of the surface. If water is not present, PCBs will move to the soil surface through simple diffusion. When water evaporates from the soil surface, an appreciable upward movement of water results through diffusion of water (Nottoli and Jacko, 1990).

Environmental PCBs are highly persistent, and quite resistant to biological or chemical degradation. Sediment-associated PCBs are usually quite bioavailable. Therefore, they tend to readily bioaccumulate in aquatic organisms and can biomagnify through the food web. They accumulate in fat tissue. The bioavailability of PCBs depends on factors such as the level and origin of organic carbon, hydrophobicity (octanol-water partition coefficient, log Kow) and degree of chlorination. Since PCB congeners have differing hydrophobicities and chlorinations, their individual bioavailability can differ significantly.

2.2.2 Pesticides

Several organochlorine pesticides such as dichlorodiphenyltrichloroethane (DDT), dieldrin, mirex (or dechlorane), toxaphene, and chlordane have been detected in the Great Lakes (Leland et al., 1973, Stevens and Nelson, 1989, Sullivan and Armstrong, 1985, Oliver et al., 1989). They are persistent and generally resistant to biological or chemical degradation. Several pesticides have been demonstrated to have high carcinogenic potency, especially dieldrin and chlordane, and pose the greatest human health risk associated with consumption of Great Lakes fish (Bro et al., 1987).

Sediment-associated pesticides can be quite bioavailable. Therefore, they can also readily bioaccumulate in aquatic organisms and can biomagnify through the food web. The bioavailability of pesticides such as DDT and mirex depends on factors such as the level and origin of organic carbon, and hydrophobicity.

2.2.3 Dioxins

Dioxins are classified as halogenated aromatic hydrocarbons. The most notably studied congener is 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8- TCDD). As the most toxic congener, it is often referred to simply as dioxin and is the reference for a number of compounds that are similar structurally and have dioxin-like toxicity. Dioxins have no commercial usefulness by themselves, and are trace impurities formed during the manufacture, chlorination, or combustion of other organic compounds.

Dioxins are comprised of over 200 congeners. In general, dioxins have low water solubility and low vapor pressure, and many are very stable . Compounds in these families will have differing properties, depending on the number and position of chlorine atoms in the molecule.

Dioxins are ubiquitous and can be found in a wide range of environments and organisms, though normally in very low concentrations. The persistent and hydrophobic nature of dioxins causes them to accumulate in soils, sediments, organic matter and waste disposal sites. Disturbance of these sites (e.g. such as dredging) may re-release the dioxins. In some animals, dioxins are highly toxic, cause cancer, and alter reproductive development and immune function. They tend to be toxic at very low concentrations and the effects of exposure are often delayed. However, the toxicological effects of dioxins can vary dramatically from species to species. Dioxins are quite resistant to biological or chemical degradation. Sediment-associated dioxins are generally bioavailable and they tend to readily bioaccumulate in aquatic organisms. While dioxins are very slowly eliminated from organism tissues, evidence for biomagnification through the food web is limited. The bioavailability of sediment-associated dioxins depends on factors such as the level of total organic carbon and hydrophobicity. Since the congeners have differing hydrophobicities, their individual bioavailability can differ.

2.3 PAHs

PAHs consist of multiple benzene rings fused together in various arrangements. PAHs are ubiquitous pollutants in Great Lakes sediments and concentrations remain high despite efforts to curb releases. Because many different PAH compounds exist and because of extreme variations in toxicity and carcinogenicity, it is often difficult to determine the impacts of PAHs in sediments. Point and non-point sources account for the high PAH concentrations often seen in dredged material. PAHs as a group are hydrophobic compounds; however there is wide variation in solubility, biodegradability, and toxicity within the group. The PAHs identified by the Environmental Protection Agency as priority pollutants are identified in Table 1. PAHs have higher water solubility than PCBs and their behavior in the water column appears to be dominated by solubility. Low molecular weight PAHs containing 2-3 benzene rings are highly susceptible to volatilization, photolysis, and biodegradation pathways and are rapidly removed from the water column.

When compared to PCBs and pesticides, PAHs can be degraded in the aquatic environment and are much less persistent. Sediment-associated PAHs are usually less bioavailable when compared to PCBs and pesticides, and show an overall relatively low potential to bioaccumulate. Nevertheless, they can bioaccumulate in aquatic organisms and are often metabolized into other compounds, some of which can be more toxic than the parent compound. PAHs usually do not biomagnify through the food web. Their bioavailability depends on factors such as the level and origin of organic carbon, and the hydrophobicity (octanol-water partition coefficient, log Kow) and molecular size of the compound. The bioavailability of PAH compounds can differ substantially.

2.4 Metals

Concentrations of metals have been correlated with toxicity at several locations on the Great Lakes (Geisy 1988) and metal induced toxicity was probably one of the main factors in the initiation of the CDF program. Several metals are included in the priority pollutant list (Table 2). In dredged material and soils, metals are typically strongly bound to the soil particles and will resist release. While metals can exert acute and chronic toxicity, they are generally regarded to be less or non-bioaccumulative. However, some metals such as cadmium and mercury, often do bioaccumulate, and mercury can even biomagnify in the food web. Methyl mercury is the most bioavailable form of mercury. There is no well-established relationship between the levels of metals in sediments and those which are bioaccumulated in aquatic organisms. Therefore, higher levels of metals in sediments are not necessary indicative of what could potentially bioaccumulate.

3. POTENTIAL CDF CONTAMINANT EXPOSURE PATHWAYS

Contaminant migration pathways are routes by which contaminants or constituents of concern (COCs) associated with confined dredged material may move from the dredged material within the site into the environment outside the site (USACE 2003). The possible pathways from an upland CDF are illustrated in Figure 2. These six pathways include:

1. Effluent discharges to surface water during filling operations and subsequent settling and dewatering.
2. Precipitation to surface runoff.
3. Leachate into ground water.
4. Volatilization to the atmosphere.
5. Direct uptake by plants growing on the dredged material (plant bioaccumulation).
6. Direct uptake by animals living on the dredged material and subsequent cycling through food webs (animal bioaccumulation).

Pathways for a **nearshore** CDF are illustrated in Figure 3. These routes include a number of pathways that are also considered for upland CDFs. However, the relative importance of pathways for a nearshore CDF differs from an upland CDF. A primary advantage of the nearshore CDF is that contaminated dredged material may remain within the saturated zone so that anaerobic conditions prevail and contaminant mobility is minimized. A disadvantage is that exterior water level fluctuations may cause a pumping action through the exterior dikes, which are generally constructed of permeable material. This pumping increases the exchange of ponded water from the CDF and increases convection of soluble contaminants from the facility. Soluble contaminants are present in the ponded water by diffusion from the settled dredged material or by expulsion of contaminated pore water from consolidating dredged material. The pumping action may result in soluble convection through the dike in the partially saturated zone and soluble diffusion from the saturated zone through the dike. Pumping action, however, is experienced primarily in CDFs that contain large-grained sediments such as sands and gravels, and is less predominant in those CDFs that contain fine-grained materials such as clays, silts, and fine sands due to the low permeability of these materials.

Pathways for **island** CDFs would be similar to nearshore sites. That portion of a nearshore or island CDF raised to above the mean high water elevation will essentially function as an upland CDF.

Effects on surface water quality, ground water quality, air quality, plants and animals depend on the characteristics of the dredged material, management and operation of the site during and after filling, and the proximity of the CDF to potential contaminant receptors.

4. LORAIN HARBOR CDF

4.1 Location

Lorain Harbor is located along the southern shore of Lake Erie at the mouth of the Black River in Lorain County, Ohio (Figure 4). The harbor is located approximately 25 miles west of Cleveland, Ohio and 90 miles east of Toledo, Ohio. The Lorain Harbor CDF is an in-water facility located to the east of the harbor's Federal navigation channels. The CDF is located lakeward of the harbor's East Breakwater Shorearm structure, and this structure constitutes the western containment wall of the CDF.

4.2 Site Features and Characteristics

Lorain Harbor is a deep-draft commercial harbor. The harbor consists of a lake approach channel, an outer harbor, and the Black River channel, which extends approximately three miles upstream from the river mouth. Harbor structures include the Outer Breakwater (2,180 feet long), East Breakwater (2,020 feet long), East Breakwater Shorearm (2,323 feet long), West Breakwater (4,000 feet long), West Pier (1,004 feet long) and the East Pier (880 feet long). The authorized Federal channel depth ranges from 29 feet in the Approach Channel to 24 feet in the River Channel.

The Lorain Harbor CDF was constructed in 1977 at a cost of $7,900,000. An Environmental Impact Statement (EIS), "Diked Disposal Facility, Site No. 7, Lorain Harbor, Lorain County, Ohio" was prepared in March 1975. The dike construction is a combination of rubble mound and steel sheet pile. The facility covers an area of approximately 58 acres and has a total capacity of 1,850,000 cubic yards. The CDF is nearly filled to capacity. The USACE is currently developing a plan for the harbor to include maximizing the life of the CDF and provide long-term management strategies for disposal of dredged material. The intent is for the CDF to be a park or recreational facility upon closure.

The CDF construction allows for dredged material to be placed within the facility either hydraulically or mechanically. Dewatering of the dredged material is accomplished by seepage through the dike walls and by discharge through an overflow weir into Lake Erie. The facility's overflow weir is located through the East Breakwater Shorearm near the southeast corner of the CDF. Treatment of the effluent is achieved through primary settling and filtration through the dike wall.

Buffalo District USACE personnel conducted a site visit of the CDF in May of 2004. The CDF contained very little vegetation, as construction equipment had recently been used on site to move and level the surface. Due to the lack of vegetation, no major indications of significant wildlife use of the area were noted at the time.

4.3 Initial Identification of Receptors of Concern

Receptors of concern are considered to be ecological receptors, and/or humans outside of the CDF, who might be exposed to contaminants associated with the dredged material. One consideration in determining receptors of concern is current and potential future land use, including surrounding land use. Receptors of concern identified for the Lorain Harbor CDF include dredging workers (when active), recreational (human) users of the site, and various wildlife, primarily waterfowl and other avian species.

It is not expected that the CDF constitutes a unique fishery resource since there are currently no open-water areas within the dikes, nor is it an important fish spawning ground. No potential presence of Federally threatened and/or endangered (T&E) species or their critical habitat is expected in the CDF based on the current habitat present at the site and the distribution of known T&E species in Ohio.

5.0 TIER I - IDENTIFICATION OF POTENTIAL CONSTITUENTS OF CONCERN AND POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS OF CONCERN

5.1 Methodology

Constituent screening evaluations have been conducted on soils contained within the Lorain Harbor CDF, to determine its potential toxicity, and determine the potential level of risk it may pose to off-site receptors such as humans, and terrestrial and aquatic biota. For the purposes of this screening, it was determined that the use of Federal screening levels or, where applicable, reference area sediment, soil, or water concentrations, would be the most appropriate approach. The choice of screening values depends on the nature of the constituents of potential concern, the receptors of potential concern, as well as the exposure pathway(s).

5.2 Available Data

Samples were collected from the Lorain Harbor CDF media in 1999 and analyzed for organic and inorganic constituents, including VOCs, PAHs, PCBs, pesticides, and metals. Media sampled included soils (and corresponding leachate), water just outside the dike, and lake water. Results of these analyses are found in Appendix A.

Only those analytes found on the Federal Priority Pollutant List (PPL) are considered in this evaluation. For example, there are results for metals such as aluminum, barium, and calcium. Since these analytes are not part of the priority pollutant list, they will not be presented here.

In 2004, additional soil samples were taken from the Lorain Harbor CDF and analyzed for base neutral and acid extractable compounds (BNAs), cyanide, and dioxin, to complete the analysis of Lorain Harbor CDF media for the PPL. Results of these analyses are presented in Appendix B.

5.3 Exposure Pathways

A preliminary conceptual site model for a Tier I evaluation of Lorain Harbor CDF, identifying the source of contaminants, migration and exposure pathways, and receptors and standards, is shown in Figure 5. This conceptual site model is based upon the six pathways of concern identified in the USACE *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual* (UTM), which are listed and described in Section 3 (USACE 2003). In addition, a seventh complete exposure pathway that of direct contact to soils and sediments by people using the CDF for recreational purposes such as camping, is identified. The complete exposure pathways to be examined in this Tier 1 analysis are: (1) volatilization from sediments and soils to air, and inhalation by workers or people visiting the site for recreational purposes, (2) release of discharge water via the weir (not currently complete, but may be a complete pathway in the near future if the CDF is filled to capacity), (3) bioaccumulation of constituents from soils by soil invertebrates, and consumption birds and small mammals at the CDF, and (4) direct contact of contaminated soils by people who work at or visit the CDF for recreational purposes.

Complete exposure pathways which link the source of constituents with receptors of concern include inhalation of volatiles, discharge of runoff water via the weir (in the future), animal uptake of organic constituents, and direct contact with constituents in the soils and sediments. The remaining three pathways, migration of constituents through or under the CDF dikes, surface runoff to a pond, and plant uptake of metals, are being eliminated from further consideration. Leaching of constituents through or under the dike to the lake is not a concern for this in-water CDF. As stated in section 6.1 of the UTM, leachate that passes through dredged material and directly enters surface waters is not generally a concern with regard to water column impacts, since the rate of flow of leachate is so low and the leachate would be mixed and diluted to background levels almost immediately. Leachate reaching groundwater and then rising to surface water is not addressed in this UTM (USACE 2003). The Lorain Harbor CDF does not contain a surface water pond. If, in the future, the CDF is regraded to allow for surface water accumulation on site, and/or newly disposed of dredged material would produce effluent, this pathway should be evaluated in the future. Finally, the CDF is currently being regraded to accept additional dredged material. Since it does not contain any vegetation, the plant uptake pathway is incomplete.

Three main categories were developed for the purposes of the screening, which encompass all of the currently complete exposure pathways identified on the conceptual site model (Figure 5). In addition, there are two other screening categories, which may be used if surface water pathways become complete in the future. These two aquatic quality criteria screening are included here for use in future planning only.

a. *Comparison with Reference or Background Levels* – Since the main objective of this evaluation is to determine whether or not constituents from the CDF are being released into the environment at levels that could pose an unacceptable risk to outside receptors, it is appropriate to distinguish concentrations of constituents within the CDF from ambient levels of constituents. The background level of constituents is typically considered at USACE hazardous, toxicological, radiological waste sites (HTRW), which use the USEPA's Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and related documents, such as the National Oil and Hazardous Substances Contingency Plan (NCP), as guidance for investigations, risk assessments, and remedial actions. Although CERCLA does not apply to these CDF evaluations, the USEPA guidance document, "Role of Background in the CERCLA Cleanup Policy" (USEPA 2002a) may be helpful in deciding whether or not background should be considered when risk management concerns are considered for the CDFs. For example, the following definition of background is offered (USEPA 2002a):

> *Background refers to constituents or locations that are not influenced by the releases from a site, and is usually described as naturally occurring or anthropogenic.*

Anthropogenic refers to natural and man-made substances present in the environment as a result of human activities (not specifically related to the CERCLA release in question). Naturally occurring refers to substances present in the environment in forms that have not been influenced by human activity.

Although the USEPA recommends that background levels of constituents be accounted for in the risk characterization of a site, it is acknowledged that where background concentrations are high relative to the concentrations of released hazardous pollutants, a comparison of site and background concentrations may help risk managers make decisions concerning appropriate remedial actions (USEPA 2002a). Furthermore, the NCP outlines criteria for determining whether or not a substance has been released into the environment, which is a determination that needs to be made as part of these CDF evaluations (NCP 1990).

The minimum standard to establish an observed release by chemical analysis is analytical evidence of a hazardous substance in the media significantly above the background level. Further, some portion of the release must be attributable to the site.

In 1999 and 2004, constituents were measured in the water just outside the CDF, and at lake reference areas. These concentrations were compared to one another to determine whether or not the constituents may be leaking through the dike at elevated amounts, (Table 3). Comparisons were made to concentrations of constituents measured in sediments throughout Ohio (Table 4) (Ohio EPA 2003). Additionally, comparisons were made to surface water collected just outside the dike and leachate analyses of soil samples to available background lake water samples.

b. *Direct Human Contact with Soils/Sediments* – For direct human contact with the soils and sediments, USEPA Region IX Preliminary Remediation Goals (PRGs) have been used to screen the soil sample results (USEPA Region IX 2002). The PRGs are risk-based concentrations, developed by the USEPA, Region IX, and are used routinely during site inspections of hazardous wastes sites by USACE risk assessors. These PRGs were developed to address two different types of human receptors: residents and workers. As stated earlier, potential human receptors at the Lorain Harbor CDF include workers and recreational users. The exposure for a recreational user may be more or less than the exposure to an industrial worker. Therefore, the most conservative approach would be to screen using both the residential and the industrial preliminary remediation goals as screening levels (Table 5). When soil sample results exceed both the residential and the industrial PRGs, then further evaluation is warranted.

This comparison to PRGs includes a consideration of inhalation of on-site VOCs from soils. The exposure assumptions used to develop the PRGs are more conservative and protective of human health for this situation, than the assumptions used in developing the OSHA air standards. Therefore, an additional comparison to OSHA air standards is not necessary.

c. *Uptake by Biota* – To determine if the material in the CDF might pose the potential for risk to humans or wildlife due to biota uptake, concentrations of constituents in the soils were compared to biosolids criteria found in USEPA Rule 503 (Federal Register 1997) (Table 6). Biosolids are the nutrient-rich organic materials resulting from the treatment of sewage sludge (the name for the solid, semisolid or liquid untreated residue generated during the treatment of domestic sewage in a treatment facility). When treated and processed, sewage sludge becomes biosolids, which can be safely recycled and applied as fertilizer to sustainably improve and maintain productive soils, and stimulate plant growth. The biosolids rule established pollutant limits in biosolids when the biosolid is applied to agricultural lands, as well as the resulting soil concentration. This comparison is appropriate because the biosolids limits were established as a result of a risk assessment that included ingestion of animals that have direct ingestion of biosolid-amended soils (which is relevant for exposure to organic compounds). The most limiting exposure pathway was used to set the criteria concentrations (USEPA 1993).

d. *Aquatic Organism Exposure* – This is currently not a complete pathway, as the Lorain Harbor CDF does not contain a surface water pond. If, in the future, the CDF is regraded to allow for surface water accumulation on site, and/or newly disposed of dredged material would produce effluent, this pathway should be evaluated in the future. Aquatic life water quality criteria, from the National Recommended Water Quality Criteria (Section 304(a)), contain two criteria; a criteria maximum concentration (CMC), and a criteria continuous concentration (CCC) (USEPA 2004). The CMC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The CCC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. Because Section 304(a) aquatic life criteria are national guidance, they are intended to be protective of the vast majority of the aquatic communities in the United States. Surface water samples were collected from just outside the dike and compared to aquatic life water quality and background lake water concentrations to determine to determine the potential for CDF constituents to leak outside the dike at elevated concentrations. Since there was no ponded water in the CDF, soil samples were also subjected to leachate analysis to simulate the potential constituents that could affect aquatic organisms in ponded water. As additional dredged material is placed in the CDF, there still exists the potential to have open ponded areas in the CDF, and/or for the excess surface water to be discharged via a weir into the lake. The comparison of water samples and aquatic life water quality criteria is made in Table 7.

e. *Human Consumption of Aquatic* Organisms – This is currently not a complete pathway, as the Lorain CDF does not contain a surface water pond. If, in the future, the CDF is regraded to allow for surface water accumulation on site, and/or newly disposed of dredged material would produce effluent, this pathway should be evaluated in the future. The USEPA, in its National Recommended Water Quality Criteria (Section 304[a]), has also developed guideline concentrations to protect humans who may consume organisms from surface water, as well as the surface water itself (USEPA 2004). Since municipal water supplies are readily available in the area of the CDF, it is assumed that the CDF water, if any, is not used as a source of drinking water. Therefore, the water quality criteria used for this evaluation are not those that are protective for people consuming both the water and organisms from the water; they are protective for people consuming aquatic organisms only. The comparison of concentrations of constituents in surface water from just outside the dike and soil leachate samples to the human health water quality criteria are made in Table 8.

5.4 Constituent Specific Screening

Details on the results of screening the data are discussed below.

5.4.1 VOCs:

a. *Comparison to Background* – No VOCs were detected from water samples collected outside the dike. No water samples were collected from inside the CDF, as no ponded areas exist. Therefore, no further evaluation of water samples is warranted.

b. *Direct Human Contact with Soils/Sediments* – Only one VOC, dichlorodifluoromethane, a common laboratory contaminant, was detected in soil samples collected within the CDF. Both the average and maximum detections of dichlorodifluoromethane in the soil samples were well below the residential soil PRG criterion (Table 5). Therefore, it can be concluded that the levels of VOCs within the soils are not high enough to pose a risk to humans via inhalation or dermal contact.

c. *Uptake by Biota* – Because of their physical properties, VOCs are typically not a bioaccumulation concern. No biosolids criteria (USEPA Rule 503) have been developed for VOCs.

d. *Aquatic Organism Exposure* – No National Recommended Water Quality Criteria for the protection of freshwater aquatic organisms have been developed for VOCs[1]. Furthermore, none of the VOCs were detected in surface water samples collected just outside the dike (Appendix A). Therefore, it is unlikely that water from just outside the dike contains VOCs at levels that would have the potential to pose an unacceptable risk to aquatic organisms. Additionally, soil leachate analyses were performed to simulate ponded surface water conditions, should it exist in the CDF. Since the results of the soil leachate analyses yielded no detections of VOCs (Table 7), it is also unlikely that any ponded surface water within the CDF would have the potential to pose an unacceptable risk to aquatic organisms.

Furthermore, because detected in soils from the CDF that were once sediments, it is concluded that they are not present at levels in the soils that could pose a risk to aquatic organisms.

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[1] For most organic constituents (other than pesticides), the EPA has not developed water quality criteria for the protection of aquatic life. The water quality criteria established for these organics is only aimed at protection of humans.

e. *Human Consumption of Aquatic Organisms* – No VOCs were detected in surface water collected just outside the dike (Table 8). Soil leachate analyses were also performed to simulate ponded surface water conditions, should it exist in the CDF. No VOCs were detected in the leachate analyses of soil samples collected from the CDF (Table 8). Therefore, VOCs do not pose a risk to humans that may consume aquatic organisms from the Lorain Harbor CDF.

f. *Conclusions for VOCs* - VOCs are not present in Lorain Harbor CDF soils or surface water just outside the dike that would pose risks to human health or ecological receptors, for any of the complete exposure pathways. No further evaluation of VOCs is necessary.

5.4.2 Metals:

a. *Comparison to Background* – To determine whether or not metals exist at elevated concentrations within the CDF, a comparison of average CDF metal concentrations with average concentrations of metals from reference areas was made (Table 4). These sediment reference values were published by the Ohio EPA (OEPA 2003). Concentrations of most metals in the Lorain Harbor CDF soils are comparable with concentrations of metals identified as reference values for Ohio. The two exceptions include cadmium and silver. The average concentration of cadmium detected in CDF soils is approximately 28 times the Ohio EPA reference value, with a maximum concentration of 214 mg/kg, and an average concentration of 23 mg/kg. The average concentration of silver detected in CDF soils is approximately 40 percent greater than its corresponding Ohio reference value.

A comparison of metal concentrations in water just outside the CDF and lake reference water values was also made (Table 3). Six of the thirteen metals shown in Table 3 have average concentrations greater than the background lake concentrations. For copper and lead, the average concentrations for surface water outside the dike differ from the lake reference concentrations by less than 1 part per billion (ppb). For the remaining analytes, mercury, nickel, thallium, and zinc, the average concentrations for these analytes ranged from 40 percent (nickel) to 257 percent (mercury) greater than the average background lake concentrations. However, it should be noted that the water outside the dike may be more polluted than the lake reference water, for factors which may well (probably) not be linked to the dredged material stored in the facility.

A comparison of soil leachate sample results to average background lake results was also made (Table 7). The concentrations of mercury, nickel, thallium, and zinc, although slightly higher, were comparable to the corresponding average background lake concentrations. Therefore, assuming the soil leachate results would be an indication of surface water concentrations, should surface water exist within the CDF, the leachate metals results were within normal background limits. Therefore, no further evaluation of the surface water metals concentrations is warranted at this time.

b. *Direct Human Contact to Soils/Sediments* – The levels of arsenic in soils exceeded both the residential and the industrial PRG (Table 5); however, the levels of arsenic in the soil samples are compatible with background levels (Table 4). In fact, the PRG for arsenic is below the background level of arsenic found in most soils across the United States. Based on this evaluation, the concentrations of arsenic in the CDF soils are not present at levels that would pose a risk to human health (Table 5). Although the maximum concentration of cadmium in the CDF exceeded the residential PRG, the average concentration of cadmium did not exceed the PRGs. Therefore, metals are not a direct contact hazard for humans.

b. *Uptake by Biota* – Because there is no vegetation at this CDF, the plant uptake pathway is currently incomplete, and does not need to be evaluated. However, it should be noted that concentrations of cadmium were also elevated in another Great Lakes CDF, Times Beach, NY. Although the concentrations of cadmium in that CDF are not as high as they are in Lorain CDF, cadmium was still elevated in earthworms and soil invertebrates in Times Beach CDF, compared to a pristine reference area on Lake Erie (USACE 2003). In addition, cadmium was accumulating in the cottonwood leaf litter at Times Beach, and apparently contributing to the slowed decomposition of leaves at the site. Voles, mallard ducks, and blackbirds from Times Beach may also have slightly higher cadmium body burdens than these organisms from a reference area. Because the levels of cadmium at Lorain are higher than what is found at Times Beach, it is possible that cadmium may have the potential to bioaccumulate in animal tissues from this CDF. Further evaluation of this pathway is warranted. Furthermore, once the Lorain CDF becomes vegetated, the plant uptake of cadmium should be evaluated.

c. *Aquatic Organism Exposure* – Surface water concentrations from just outside the Lorain Harbor CDF and soil leachate concentrations from samples collected within the facility were compared to National Recommended Water Quality Criteria for protection of freshwater aquatic organisms (Table 7). Leachate analyses of soils collected within the CDF were performed to simulate ponded surface water conditions, should it exist in the CDF.

The maximum concentrations of copper and lead in the surface water collected just outside the CDF exceeded the criteria continuous concentration (CCC), but did not exceed the criteria maximum concentration. The average concentration of copper for surface water samples collected outside the dike was below the CCC and CMC criteria, but the average lead result from outside the dike surface water slightly exceeded the CCC criterion. Maximum concentrations of copper and lead from background lake water also exceeded the CCC criteria but were below the CMC criteria. The average concentration of copper for the background lake water was below the CCC and CMC criteria, but the average lead result slightly exceeded the CCC criterion. Maximum soil leachate concentrations for copper and lead were below the CCC and the CMC criteria. Since the copper and lead results from the surface water samples from outside the dike were comparable to background lake water, and since the leachate copper and lead results were below water quality criteria, no further evaluation of copper and lead is warranted.

Maximum and average concentrations of cadmium detected in soil leachate are above the CCC, but below the CMC. Therefore, no further evaluation of cadmium for protection of aquatic life, should it exist on the CDF, is warranted.

The maximum detected concentration of mercury in surface water just outside the dike was greater than the CMC. The average concentration of mercury from the surface water just outside the dike was below the CCC and CMC. A total of seven surface water samples were collected for mercury from just outside the dike area. Only one of the seven mercury results exceeded the CMC; none of the other samples exceeded the CCC. The average and maximum mercury results from the soil leachate samples were well below the water quality criteria. Therefore, based on this screening, no further evaluation of mercury is warranted.

Average and maximum silver concentrations for surface water outside the dike, background lake water, and the soil leachate samples exceeded the CMC criteria. The exceedances for the surface water samples are due in large part to the detection limit being slightly higher than the CMC criterion. Silver was reported as non-detected in all surface water samples from outside the dike at a detection limit of 5 μg/l, whereas the CMC criterion is 3.4 μg/l. Background lake water samples had detections of silver greater than the CMC. The average soil leachate detection of silver was minimally greater than the CMC at 3.77 μg/l (CMC-3.4 μg/l). Nevertheless, since the average silver concentrations for the surface water samples collected outside the dike and the soil leachate samples collected within the CDF are less than the background lake water average silver concentrations (Table 7), no further evaluation of silver is warranted.

Therefore, based on this screening, it is unlikely that the metal concentrations from open ponded water within the Lorain Harbor CDF, should it exist, would have the potential to pose an unacceptable risk to aquatic organisms, should this pathway become complete in the future.

e. *Human Consumption of Aquatic Organisms* – Water quality criteria for the protection of human health have only been developed for a few metals (Table 8, USEPA 2004). The concentrations of these metals from surface water just outside the dike and leachate analyses of soil samples from the CDF are lower than their applicable water quality criteria with the exception of those values reported for arsenic and thallium. The average and maximum arsenic concentrations from surface water from just outside the dike and the leachate analyses of soil samples collected from within the CDF were reported as "less-than" values. That is to say that arsenic was not reported as detected but the laboratory's method detection limit was greater than the respective water quality criteria. Given that there were no actual detections of arsenic from samples collected in support of this project, no further evaluation of arsenic is warranted. There is some uncertainty however, in concluding that there is no risk to human health via consumption of aquatic organisms from the Lorain Harbor CDF, since the arsenic detection limit in water is greater than the water quality criteria.

Although the maximum outside dike water concentration of thallium, and the reported detection limits for soil leachate of thallium are all above the water quality criteria, since thallium was not identified as being above background or Ohio sediment reference value concentrations in the CDF, no further evaluation of this pathway for thallium is warranted.

f. *Conclusions for Metals* – A few metals were identified as being above background or reference concentrations of metals. Cadmium may be a concern via animal bioaccumulation, or plant bioaccumulation if the CDF becomes vegetative in the future. In addition, if in the future surface water ponds form on the CDF, then the surface water pathway should be re-evaluated at that time.

5.4.3 PAHs:

a. *Comparison to Reference or Background* – Background soil samples were not collected for PAH analyses. In water, PAHs were not detected in surface water collected just outside the dike nor were they detected in leachate analyses of soil samples collected from within the CDF. The leachate sample results can be used as a comparison as to what could be expected to be detected in ponded water should it exist within the CDF. The PAH results of the surface water from just outside the dike and the soil leachate sample results were comparable to background lake water PAH data (see Table 7).

b. *Direct Human Contact* – There were several PAHs detected at elevated concentrations in the Lorain Harbor CDF soils. These include: anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h) anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene. When the maximum detected concentrations of these constituents are compared to the PRGs, several PAHs exceed the residential PRGs (Table 5). These PAHs are benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h) anthracene, and indeno(1,2,3-cd)pyrene. There is no PRG for phenanthrene. With the exception of indeno(1,2,3-cd)pyrene, all of the maximum detected and average concentrations of PAHs in soils that exceeded residential PRG criteria also exceeded the corresponding industrial PRG.

However, the PRGs for these carcinogenic PAHs are based on an incremental lifetime cancer risk of one in a million (1E-06), and were developed for screening purposes only (USEPA Region IX 2002). The upper threshold for an acceptable cancer risk is one in ten thousand (1E-04) (NCP 1990). USEPA and USACE use an acceptable cancer risk range of 1 in 1 million to 1 in ten thousand for their HTRW sites. The PRGs are conservatively set at the lower end of this range, 1 in 1 million excess cancers. Up to 100 times this, or a cancer risk in 1 in ten thousand, is still considered an "acceptable" risk by the USEPA. With the exception of the concentration of benzo(a)pyrene, none of the maximum detected PAHs in soil exceeds one hundred (100) times the residential PRG for these carcinogenic PAHs. None of the average PAH concentrations in soil exceeded one hundred (100) times the industrial PRG; therefore, the potential for human health risks from exposure to these PAHs is not unacceptable. Furthermore, the exposure assessment used to develop the PRGs assumed direct contact with contaminated soils for an extended period of time in a residential or industrial land use, and considered incidental ingestion, inhalation of fugitive dust, and dermal contact with soils. However, the current and most likely future use of Lorain would not be for residential or industrial use, but rather, for occasional recreational use. The recreational exposure is much less than the assumed residential or industrial use, and so the subsequent health risks would also be much less for the recreational user.

c. *Uptake by Biota* – As non-polar organics, PAHs may have the potential to bioaccumulate, although probably not to the same extent as chlorinated hydrocarbons. This is due to the ability of most organisms to at least partially metabolize PAHs and excrete some of the PAH residues.

To evaluate the potential for PAHs to bioaccumulate, the concentrations of PAHs from soil samples from within the CDF were compared to criteria established in the biosolids USEPA Rule 503. As seen in Table 6, the only PAH biosolids limit of is 15 ppm for benzo(a)pyrene. The maximum detection of benzo(a)pyrene exceeded the biosolids limit, whereas the average detectable concentration was below the biosolids limit. No corresponding soils concentration limit has been established. The 15 ppm limit was established based on the limiting exposure pathway in the biosolids risk assessment, which, for benzo(a)pyrene, was determined to be direct ingestion of biosolids by a child (USEPA 1993). No limit for benzo(a)pyrene was established based on direct animal uptake from contaminated soils, because these pathways were determined to have minimal risk during a screening, or hazard ranking, phase of the risk assessment (USEPA 1993).

Dredged sediment and the resulting consolidated soils would have significantly less organic carbon content than biosolid-amended soils, which should make organic contaminants more bioavailable (and hence potentially more toxic) from dredged sediments than biosolid-amended soils. Therefore, comparison to the USEPA Rule 503 limits alone may not be enough information to conclude that PAHs do not pose the potential for unacceptable risk due to the animal uptake pathway.

Another line of evidence which may be used to determine whether or not levels of PAHs in Lorain Harbor CDF soils would bioaccumulate to adverse levels in wildlife visiting the site, is the comparison of PAH concentrations at Lorain Harbor CDF with PAH concentrations at Times Beach CDF. The Times Beach CDF has been extensively studied in the past, and conclusions may be inferred by making use of the data collected at this nearby Lake Erie CDF (Stafford et al. 1991, USACE-LRB 2003). A comparison of the concentrations of PAHs at Times Beach and Lorain Harbor CDF can be seen in Tables 9 and 10. In addition, the concentration of total organic carbon (TOC) at the two sites was also compared, since TOC may affect the bioavailability of PAHs.

As can be seen in Table 9, average PAH levels in Times Beach oxidized soils are approximately one-sixth the PAH levels in Lorain Harbor CDF oxidized soils. However, average TOC levels at Times Beach are almost twice as high as the TOC levels at Lorain

Harbor CDF. Therefore, it is likely that PAHs may be more bioavailable from the facility's oxidized soils than Times Beach oxidized soils, but it is not possible to say what ecological effect this might have. At Times Beach CDF, experiments were completed to examine the uptake of contaminants from the CDF soils into earthworms. Concentrations of PAH components in native worms from Times Beach were 10 to 50 times as high as in the same species from a reference site (Marquenie et al. 1987). However, it is not really clear whether these elevated levels of PAHs in earthworms is adversely affecting either the earthworms, or organisms higher in the food chain, such as the American woodcock, robin, or shrews at Times Beach. Although no shrews were observed at Times Beach, the exact reason for this apparent lack of shrews has not been determined. An ecological risk assessment was completed for Times Beach, indicating that shrews were at a higher risk from exposure to contaminated soils at Times Beach. However, elevated PAHs in earthworms only accounted for approximately 1% of shrews' risk, while heavy metals in soils and earthworms (arsenic and cadmium) accounted for the majority of the modeled risk to shrews (USACE-LRB 2003).

The levels of PAHs were measured in tissues of animals and birds caught at Times Beach (Stafford et al. 1991). The levels of PAHs in the Times Beach tissues were all below detection limits, between 0.3 to 1 ppm wet weight. However, this study of tissue levels of contaminants did not include an examination of insectivores, such as woodcocks, robins, or shrews, which would have the most direct contact to earthworms. Furthermore, most bird and animal species at Times Beach appear to be thriving. The risk of PAHs to birds is difficult to determine, given the lack of toxicity data on PAHs to birds.

As seen in Table 10, average levels of PAHs in reduced soils at Times Beach are about twice as high as PAHs in Lorain Harbor CDF reduced soils. Average TOC levels in reduced soils at Times Beach are about 7 times higher than average TOC levels from reduced soils at Lorain Harbor CDF. However, there is not as much animal exposure to the reduced soils as to the upper oxidized soils, so these results are not as important in drawing conclusions concerning relative levels of PAH bioavailability between the two sites.

In conclusion for the animal uptake pathway for PAHs, it is possible that PAHs from oxidized soils at Lorain Harbor CDF may be bioavailable to terrestrial organisms, and have the potential to accumulate in earthworms. Further evaluation of this pathway may be warranted.

d. *Aquatic Organism Exposure* – No National Recommended Water Quality Criteria for the protection of freshwater aquatic organisms have been developed for PAHs[1] (USEPA 2004). If ponded water were to exist at Lorain Harbor CDF in the future, then the soils in the CDF would be sediment, and could be compared to sediment consensus effects concentrations. This comparison reveals that both the sediment consensus TEC, as well as the sediment consensus PEC, are exceeded for all soil concentrations of PAHs (Table 7A). Therefore, if the CDF were to be re-graded to allow for surface water ponding in the future, this pathway would have to be evaluated further. As this is not a currently complete exposure pathway, no further evaluation at this time is warranted.

e. *Human Consumption of Aquatic Organisms* – Water quality criteria have been developed for the protection of human health (via consumption of aquatic organisms) for PAHs, and are presented in Table 8. None of the PAHs were detected in surface water collected just outside the CDF. Furthermore, soil samples collected within the CDF were subjected to leachate analysis. The leachate sample results can be used as a comparison as to what could be expected to be detected in ponded water should it exist within the CDF. No PAHs were detected in the leachate samples. However, there is some uncertainty in concluding that there is no risk to human health via consumption of aquatic organisms from the Lorain Harbor CDF, since some of the detection limits for PAHs in water are greater than the water quality criteria. However, it should be noted that the PAH results from the leachate samples and surface water samples collected just outside the dike are comparable to background lake water PAH results. If the CDF were to be re-graded to allow for surface water ponding in the future, this pathway would have to be evaluated further. As this is not a currently complete exposure pathway, no further evaluation at this time is warranted.

f. *Conclusions for PAHs* – PAHs were detected above reference levels in Lorain Harbor CDF soils. For the direct human contact pathway, the levels of PAHs are not elevated enough to pose a risk to human health. However, it is not certain whether or not bioaccumulation of PAHs from Lorain Harbor CDF soils could pose a risk to terrestrial organisms (birds and mammals) that visit the site. Further evaluation of this pathway is warranted. If in the future, surface water ponds on the CDF, further evaluation of these newly complete exposure pathways would be necessary.

5.4.4 PCBs

PCBs, specifically Aroclor-1254, were detected in one soil sample collected from the CDF. Leachate analyses of the soil samples yielded PCB results that were reported as less than detectable.

a. *Comparison to Background* – No PCBs were detected from water samples collected outside the dike. Therefore, no further evaluation of water samples is warranted.

b. *Direct Human Contact with Soils/Sediments* – The average and maximum detected Aroclor-1254 soil sample results exceeded the corresponding residential PRG criterion, but were below the industrial PRG criterion (Table 5). Therefore, the potential for human health risks from industrial or recreational exposure to PCBs is not unacceptable.

c. *Uptake by Biota* – The maximum and average PCBs results from soils collected from the CDF were below the associated biosolid limit. The critical exposure pathway for the PCB biosolid limit was an adult eating animal product, in which the animals were eating the biosolid. As this pathway considered bioaccumulation, the potential for human health risks from animal uptake of PCBs is low. Although the biosolids rule limit does not consider if the bioaccumulation of PCBs is potentially harmful to the animals themselves, the measured concentrations of PCBs at the site are all below 1 ppm, which is considered a threshold for protection of terrestrial ecosystems (USEPA 2001).

d. *Aquatic Organism Exposure* – Leachate analyses of the soil samples yielded PCB results that were reported as less than detectable. However, the detection limits were greater than the National Recommended Water Quality Criteria for the protection of freshwater aquatic organisms, CCC (Table 7). Therefore, there is some uncertainty as to whether or not levels of PCBs in the leachate are really below the CCC. However, as PCBs were only detected in one of fourteen soil samples taken, PCBs are not likely to be a widespread problem at the CDF. If the CDF were to be re-graded to allow for surface water ponding in the future, this pathway would have to be evaluated further. As this is not a currently complete exposure pathway, no further evaluation at this time is warranted.

e. *Human Consumption of Aquatic Organisms* - Leachate analyses of the soil samples yielded PCB results that were reported as less than detectable. However, the detection limits were greater than the National Recommended Water Quality Criteria for the protection of human health (Table 8). Therefore, there is some uncertainty as to whether or not levels of PCBs in the leachate are really below the human health criterion. However, as PCBs were only detected in one of fourteen soil samples taken, PCBs are not likely to be a widespread problem at the CDF. If the CDF were to be re-graded to allow for surface water ponding in the future, this pathway would have to be evaluated further. As this is not a currently complete exposure pathway, no further evaluation at this time is warranted.

f. *Conclusions for PCBs* – PCBs are not present in Lorain Harbor CDF soils or surface water just outside the dike that would pose risks to human health, plants, or animals via direct human contact with the CDF soils. However, if the CDF were to be re-graded to allow for surface water ponding in the future, this pathway would have to be evaluated further.

5.4.5 BNAs:

Additional soil samples were collected in May 2004 to complete the analysis of Lorain Harbor CDF media for the priority pollutant list of BNA compounds. No BNAs other than bis (2-ethylhexyl) phthalate (BEHP) and dibenzofuran were detected in the Lorain Harbor CDF area soils. As noted previously, BEHP is a common laboratory contaminant. The concentrations detected in the media from the Lorain Harbor CDF are typical concentrations that can be attributable to laboratory contamination. Additionally, average and maximum concentrations of dibenzofuran detected in the 1999 soil samples were below residential PRGs and soil leachate PAH concentrations were reported as less than values that were comparable to background lake water concentrations. As such, no BNAs (other than the PAHs discussed previously) were present in soils that would pose a risk to human health or ecological receptors, for any of the complete exposure pathways. Therefore, no further evaluation of BNAs is necessary.

5.4.6 Cyanide:

Additional soil samples were collected in May 2004 to complete the analysis of Lorain Harbor CDF media for the priority pollutant list, including cyanide. There are very few evaluation criteria to compare the cyanide results to. There are no background levels or biosolids criteria values relative to cyanide. However, residential and industrial PRG criteria do exist for cyanide. The cyanide concentrations reported for the soils from the Lorain Harbor CDF area were well below the USEPA PRG criteria (both residential and industrial). As such, it is unlikely that the cyanide concentrations in the Lorain Harbor CDF area soils and pose a risk to human health or the environment.

5.4.7 Dioxin:

Additional soil samples were collected in May 2004 to complete the analysis of Lorain Harbor CDF media for the priority pollutant list, including dioxin. One soil sample was selected for dioxin analysis from the three soil samples collected in May 2004. The one soil sample was chosen for dioxin analysis because it had the highest concentrations of PAHs and an elevated TOC concentration relative to the other two samples; thus increasing the potential for a bias in dioxin results.

The USEPA has decided that it is not necessary to regulate dioxin in land-applied sewage sludge (USEPA 2003). As part of their decision, the USEPA performed a Screening Ecological Risk Analysis (SERA) on the risks to wildlife due to exposure to dioxins from land-applied sewage sludge. While the estimates are not without some uncertainty, the SERA indicates that wildlife should not be significantly impacted as a result of exposure to dioxins in land-applied sewage sludge.

As for PAHs and VOCs, no National Recommended Water Quality Criteria for the protection of freshwater aquatic organisms have been developed for dioxin[1] (USEPA 2004).

The dioxin analysis of the selected soil sample from Lorain Harbor CDF did not detect a measurable concentration of dioxin, at a detection limit that was one and two orders of magnitude below the residential and industrial USEPA PRG values (Table 5). Therefore, dioxin is not a direct contact hazard for humans at the site. Additionally, due to its low aqueous solubility, dioxin is not expected to be present at detectable concentrations in the ponded water in Lorain Harbor CDF, should it exist.

Based on the evaluation above, dioxin does not appear to be an environmental concern at the Lorain Harbor CDF, and therefore, no further evaluation of dioxin is warranted.

5.4.8 Pesticides, and Explosives:

No pesticides or explosives were detected in any samples taken at the Lorain Harbor CDF.

Based on surrounding land use as well as the results of sampling noted above, pesticides, and explosives are not expected to be present in appreciable levels in the Lorain Harbor CDF. Therefore, these constituents are eliminated from further evaluation.

5.5 Tier I Conclusions and Recommendations

The following conclusions about contaminant releases and contaminant-related environmental effects from Lorain Harbor CDF can be made. These Tier I conclusions are based upon a review of information that currently exists on the CDF, focusing on the 1999 and 2004 results of sampling and analysis of Lorain Harbor CDF soils and water. It is assumed that sediments that are currently being placed into the CDF, as well as sediments to be dredged from these same areas in the future, are and will continue to be, less contaminated than the sediments placed in the CDF in the past.

1) *Conclusions for VOCs* - VOCs are not present in Lorain Harbor CDF soils or surface water just outside the dike that would pose risks to human health or ecological receptors, for any of the complete exposure pathways. No further evaluation of VOCs is necessary.

2) *Conclusions for Metals* - A few metals were identified as being above background or reference concentrations of metals. Cadmium may be a concern via animal bioaccumulation, or plant bioaccumulation if the CDF becomes vegetative in the future. In addition, if in the future surface water ponds form on the CDF, then the surface water pathway should be re-evaluated at that time.

3) *Conclusions for PAHs* - PAHs were detected above reference levels in Lorain Harbor CDF soils. For the direct human contact pathway, the levels of PAHs are not elevated enough to pose a risk to human health. However, it is not certain whether or not bioaccumulation of PAHs from Lorain Harbor CDF soils could pose a risk to terrestrial organisms (birds and mammals) that visit the site. Further evaluation of this pathway is warranted. If in the future, surface water ponds on the CDF, further evaluation of these newly complete exposure pathways would be necessary.

4) *Conclusions for PCBs* - PCBs are not present in Lorain Harbor CDF soils or surface water just outside the dike that would pose risks to human health, plants, or animals via direct human contact with the CDF soils. However, if the CDF were to be re-graded to allow for surface water ponding in the future, this pathway would have to be evaluated further.

5) *Conclusion for BNAs, Cyanide, Dioxin, Pesticides, and Explosives* - No BNAs (other than the PAHs discussed previously) were present in soils that would pose a risk to human health or ecological receptors, for any of the complete exposure pathways. Therefore, no further evaluation of BNAs is necessary. No pesticides, explosives, or dioxin were detected in any samples taken at Lorain Harbor. Cyanide concentrations reported for the soils from the Lorain Harbor area were well below the USEPA PRG criteria (both residential and industrial). Based on the analyses conducted, these constituents are not expected to be an environmental concern for the Lorain Harbor

CDF. Therefore, BNAs, Cyanide, Dioxin, Pesticides, and Explosives are eliminated from further evaluation.

6) Leaching of Lorain Harbor constituents is not a concern due to the placement of the CDF in open water, as well as absence of a groundwater aquifer for drinking water purposes at this site. No further evaluation of the leaching pathway is warranted.

7) Bioaccumulation of metals from soils (plant uptake) is not currently a complete exposure pathway, as the Lorain Harbor CDF is unvegetated. If, in the future, the CDF becomes vegetated, then further evaluation of this newly completed exposure pathway would be warranted.

8) If, in the future, the CDF is regraded to allow for surface water accumulation on site, and/or newly disposed of dredged material would produce effluent, then aquatic pathways should be evaluated in the future.

This Tier I evaluation concluded that there is enough information to dismiss from further concern, most of the contaminants in the CDF. However, there is not enough evidence to eliminate the potentially complete pathway of bioaccumulation of PAHs and cadmium to terrestrial organisms (birds and mammals) who visit the site. In addition, cadmium may have the potential to accumulate in vegetation, once it becomes established on the CDF in the future. Before any decision regarding need for management actions in this CDF are made, this potentially complete exposure pathways and contaminants should be evaluated in subsequent tier evaluations, as recommended in the UTM. For evaluation of the potential for animal bioaccumulation of PAHs and cadmium, the UTM recommends performing earthworm uptake studies (Tier III). For evaluation of plant uptake of cadmium, the plant uptake program and DTPA testing may be completed in a Tier II analysis, followed by plant uptake studies (Tier III), if needed. It should be noted that addition of a layer of cover material should eliminate most exposures and the potential risks associated with these contaminants.

6. TIER II EVALUATION

6.1 Tier II Prediction of Plant Bioaccumulation Potential

The Tier I evaluation determined plant and animal uptake were contaminant pathways of concern and further testing was necessary to evaluate the potential for uptake by plants and animals exposed to dredged material in the Lorain Harbor CDF. The UTM (USACE, 2003) suggests proceeding to Tier II testing if a decision cannot be reached in Tier I. The procedures for predicting plant bioaccumulation potential under Tier II includes (1) chemical analysis of plant tissues growing in the CDF and comparison to like tissues growing in a reference or background area and/or (2) the chemical extraction of dredged material using a chelating agent diethylenetriaminepentaacetic acid (DTPA) and comparison to chemical extraction of a reference soil.

The comparison of contaminant concentrations in plant materials collected from a CDF and reference site requires that the same plant species must exist on both sites. This can sometimes be a difficult proposition and comparison between dissimilar species may not be valid as uptake potential varies by species. The DTPA procedure has been used in a number of studies to successfully predict plant bioaccumulation from dredged material placed in terrestrial (wetland and upland) environments (Lee, Folsom, and Engler 1982; Lee, Folsom, and Bates 1983; U.S. Army Engineer Waterways Experiment Station, 1987) and compared well with actual concentrations of metals in leaves of bioassay plants. However, actual plant exposures tend to be a more reliable method of evaluating plant response to contaminant exposures.

For the reasons described above it was recommended by the developers of the UTM at the US Army Engineer Research and Development Center, Vicksburg, MS (ERDC-Vicksburg) to skip the Tier II testing and proceed directly to the more quantitative Tier III bioassay test procedure.

6.2 Tier II Theoretical Bioaccumulation Potential

The Tier II animal screen suggests the use of theoretical bioaccumulation potential (TBP) for predicting bioaccumulation of nonpolar organics. This includes the chlorinated hydrocarbon pesticides, many other halogenated hydrocarbons, PCBs, many PAHs including all the priority pollutant PAHs, dioxins, and furans. However, the TBP been used mainly for calculating bioaccumulation of nonpolar organics in aquatic animals and its utility for predicting bioaccumulation in soil invertebrates has not been confirmed to date. Again, UTM developers at the ERDC-Vicksburg suggested proceeding directly to the Tier III bioassay procedure.

6.3 Soil Screening Levels for Beneficial Use

The use of dredged material for beneficial purposes includes the use of the CDF and material within once the CDF is filled and no longer used for placement of dredge material. The Great Lakes Commission developed a regional testing manual (Great Lakes Commission, 2004) for the upland beneficial use of dredged material in the Great Lakes Area. State guidance or regulatory criteria for contaminant limitations is provided in the manual http://www.glc.org/upland/download/UplandFramework_2.pdf. This is summarized in Table 11. While criteria are not provided for all contaminants, many are and may be used to determine suitability of dredged material for specific purposes. For the State of Ohio, soil criteria for residential cover and unrestricted fill are adapted from Canadian Soil Quality Guidelines (Canadian Council of Ministers of the Environment, 2006 http://www.ccme.ca/assets/pdf/ceqg_soil_summary_table_v6_e.pdf). Ohio criteria for industrial use is based on Ohio sewage sludge rules (Ohio Administrative Code 3745-40) http://www.epa.state.oh.us/dsw/rules/3745-40.html. The monthly average concentrations are shown in Figure 6. The Canadian Soil Quality Guidelines are provided in Figure 7.

7.0 TIER III EVALUATION

7.1 Tier III Plant and Animal Bioaccumulation Tests

The purpose of Tier III plant and animal bioaccumulation test is to determine the potential migration of contaminants from the CDF through the food-chain. The bioavailability of contaminants to plants and animals exposed to dredged material in the CDF is required to determine potential risks outside the CDF. For most contaminants, there is not a linear relationship between concentration in dredged material and bioavailability to plants and soil invertebrates, thus actual biological exposures to the dredged material in question must be conducted. The UTM recommends conducting bioassays on the dredged material in question as well as on a reference sediment or soil. Actual bioaccumulation in tissues exposed to dredged material and reference soil contaminants determines the potential risks posed to food webs in comparison to local conditions.

The Tier III procedure for plants determines the potential bioaccumulation of contaminants of any contaminant under freshwater terrestrial conditions by *Cyperus esculentus*, a representative plant species found in both wetland and upland soil conditions. The plant bioassay provides information on (1) ability of the dredged material to support plant survival and growth, (2) bioavailability and mobility of contaminants from soil to the above-ground plant tissues and (3) the potential for contaminant movement to higher organisms (e.g., birds, mammals, amphibians, reptiles) from off the site linked to plants in the food web.

The Tier III procedure for animals determines the potential bioaccumulation of any contaminant under freshwater terrestrial conditions by earthworms, a representative soil invertebrate known to accumulate a wide variety of contaminants from the soil in which it lives. This test procedure has been established as ASTM SE-1676 Standard Procedure (ASTM 1997). The bioaccumulation assay provides information on (1) bioavailability and mobility of contaminants from soil to the soil-dwelling earthworms, and (2) the potential for contaminant movement to higher organisms (e.g., birds, mammals, amphibians, reptiles) from off the site linked to worms in the food web.

7.2 Regulatory Guidance

Chapter 1 of the UTM (USACE, 2003) discusses the regulatory authorities governing placement of dredged material in CDFs. The direct uptake or bioaccumulation of contaminants by wetland and terrestrial plants and animals is not directly governed by any specific regulations. The plant and animal uptake pathways for CDFs receiving dredged material are unique in that dredged material is not sewage sludge, solid waste, or an industrial byproduct and therefore the regulatory authorities over those materials cannot be applied to dredged material in a CDF. Once dredged material is placed in a CDF it is essentially a soil and since it is generally from the adjacent waterway it may contain low levels of contaminants from various anthropogenic sources. Statutory or regulatory regimes used for land application of sludge or industrial waste products were developed based on the risks posed by the use of those materials and are not applicable for CDF placement of dredged material. The general mandate under NEPA requires evaluations of the uptake pathways, since uptake and subsequent movement of contaminants into food webs may result in impacts outside the CDF. In the UTM, the potential uptake of contaminants into plant and animal tissue is compared to that for a reference material representative of soils in the vicinity of the CDF. Generally, if the dredged material uptake exceeds that for the reference, the potential environmental impact of the plant or animal uptake pathway outside of the CDF is evaluated in the context of a risk assessment or the pathway is simply eliminated (control plant growth or implement animal exclusion techniques).

For beneficial uses of dredged material there is little guidance for determining suitability of dredged material for any given use based on its contaminant concentrations. The soil screening levels described in section 6.3 above can be used to determine suitability of dredged material for beneficial purposes. Some states use various soil quality criteria derived form a number of sources including USEPA 503 Rule sewage sludge limitations, ecological/human health soil screening levels, remediation or cleanup goals for superfund sites, etc. The use of these varies in regulatory application by states and some are applied with a pass (suitable) or fail (not suitable) philosophy. In the testing protocols under the UTM, a Tier II screening level should determine whether suitability can be determined at the Tier II level or whether further testing under Tier III is required to make that decision. In that context, soil criteria based on protection of ecological or human health should be sufficient to determine if a dredged material is suitable for specific beneficial uses and to determine if additional testing is required.

7.3 Methods and Materials

7.3.1 Sample Collection and Preparation

Samples of dredged material and reference soils were collected by USACE-LRB personnel during the month of April, 2006. A 13-liter polyethylene bucket was filled from three locations within the Lorain Harbor CDF the Monkey Island Reference site for a total of three buckets from each site. The buckets were sealed and shipped to the ERDC-Vicksburg. Upon sample receipt the three buckets from each site were mixed to form one composite sample each for the Lorain Harbor CDF and the Monkey Island Reference site.

7.3.2 Plant and Earthworm Bioassays

The plant and earthworm bioassays were conducted on both materials following the methods in the UTM (USACE, 2003). The plant bioassay followed Section H.3 Tier III – Laboratory Plant Bioaccumulation Procedures in Appendix H of the UTM. After completion of the plant bioassay, the soil materials were remixed within each bioassay unit and the earthworm bioassay was conducted on that same material following procedures in Section G.3 Tier III - Terrestrial Animal Bioaccumulation Test, found in Appendix G of the UTM. Both tests were conducted in the ERDC-Vicksburg facilities.

7.3.3 Evaluation Parameters

Samples of each composite were analyzed for metals, PAHs and total organic carbon (TOC). Results of chemical analysis were compared to soil criteria described in Section 6.3. At the end of the bioassay period, plant biomass was determined on the above-ground portion of the plant. Above-ground plant tissues were dried, ground and analyzed for arsenic, silver, cadmium, chromium, copper, mercury, nickel, lead and zinc. Earthworms were collected at the end of the bioassay period, counted and weighed to determine effects on survival and growth. Earthworm tissues were ground and analyzed for PAHs. Tissue concentrations of contaminants in both plants and earthworms exposed to CDF dredged material was compared to reference soil tissues. For determination of means, values below the method detection limit (MDL) were set at the MDL numerical value.

Note: While only PAH and cadmium were identified in the Tier I assessment requiring further evaluation, additional metals were included in Tier III for research and testing validation support.

7.4 Results and Discussion

7.4.1 Physical and Chemical Soil Characteristics

Characteristics of the Lorain Harbor CDF and Monkey Island Reference site are shown in Table 12. The Lorain Harbor CDF dredged material contained higher clay content and had a higher pH response (neutral) than the Monkey Island Reference. However, the pH of both materials was sufficiently high to minimize uptake of metals. Total organic carbon (TOC) was less than half the TOC content of the Monkey Island Reference soil but both were within normal TOC levels for mineral soils in the region. Results of metals analysis of the Lorain Harbor CDF and Monkey Island Reference soil are shown in Table 13. Concentrations of all metals, except arsenic, exceeded concentrations of metals in the Monkey Island Reference soil. However, concentrations of metals did not exceed the lowest soil criteria for beneficial use or soil environmental quality guidelines (no criteria are available for silver).

Results of analysis for PAHs are shown in Table 14. Except for naphthahalene and 2-methylnaphthylene, all PAH compounds in Lorain Harbor CDF dredged material exceeded concentrations in the Monkey Island Reference soil.

There are few soil criteria for PAH compounds currently developed which implies the uncertainty associated with their bioavailability in soil. The Canadian Environmental Quality Guidelines (CCME, 2006) set Naphthalene and Benzo(a)pyrene at 0.1 mg kg^{-1} for agricultural use and 0.7 mg kg^{-1} for residential/park and industrial use. Both the CDF and Reference exceed the lower criteria but not the higher. However, if a screening level decision could be made at this point the Lorain Harbor dredged material could not be deemed suitable for beneficial use since there are no criteria for remaining PAH compounds that are of concern. Since the TBP has not been sufficiently verified with terrestrial invertebrates (as discussed in Section 6.2) biological uptake experiments are necessary to determine bioaccumulation potential. Other soil properties including TOC, clay content and hard carbon (soot and coal dust) may influence the availability of PAH through various contaminant pathways. Conducting actual exposure tests are necessary to determine actual uptake of contaminants expected under field conditions.

7.4.2 Plant Growth and Uptake of Metals

Total above-ground plant biomass after 45 days of growth is shown in Table 15. The dredged material from Lorain Harbor (Figure 8) was found to produce slightly more robust plant growth compared to the Reference soil (Figure 9). The mean fresh weight yield was 143.4 grams in the Lorain Harbor dredged material compared to 102.8 grams in the Monkey Island Reference. The higher concentration of metals in Lorain Harbor dredged material did result in higher mean plant tissue concentrations compared to Monkey Island results, Table 16. While concentrations of arsenic, cadmium, chromium, lead, mercury, and nickel in plants grown in Lorain Harbor dredged material were higher, they were not statistically different than concentrations in plants grown in Monkey Island Reference soil.

There are no specific regulatory limitations on ecological plant tissue contaminants and any ecological impacts within the plant pathway must be determined on a site-specific basis. Various guidelines are available and are useful in determining the need for further evaluations pertaining to ecological/human health risks. The European Commission (EU) has set action levels contaminants in foodstuffs (http://eur-lex.europa.eu/LexUriServ/site/en/consleg/2001/R/02001R0466-20051129-en.pdf) which can be compared to plant tissue levels. Action levels for lead and cadmium in leafy vegetables (wet weight), is 0.3 and 0.2 mg kg^{-1}, respectively. Converting for the wet weight concentration, the CDF plant tissue lead and cadmium would be 0.77 and 0.27 mg kg^{-1}, respectively. Using a fresh to dry weight conversion of 0.052 for lettuce (Baes et al., 1984), the dry weight action level would be 5.76 mg kg^{-1} for lead and 3.85 for cadmium. Lead in CDF grown plants exceed the EU action level while both the CDF and Monkey Island grown plants exceed the action level for cadmium. The EU has no published action levels for additional metals in plant tissues.

The USEPA is developing soil screening levels for ecological protection (Eco-SSLs) and guidance on some contaminants is available: (http://www.epa.gov/ecotox/ecossl/). Of the metals analyzed in this study, USEPA Eco-SSLs are provided for arsenic, cadmium, chromium, copper, and lead and are summarized in Table 17. Soil composite concentrations for arsenic, cadmium, chromium, copper and lead from Table 13 do not exceed these Eco-SSL soil concentrations. Based on the Eco-SSL guidance, plant transfer of these metals from the Lorain Harbor dredged material to avian and mammalian species would not be a concern. However, since actual plant bioaccumulation of metals was determined, additional assessment of potential food-chain impacts can be determined. Acceptable concentrations of contaminants in plant tissues that would be ingested by receptor animal species can be calculated based on the following equation:

$$C_{plant} = (I \times BW)/(F \times CR)$$

Where:
I is the acceptable daily intake of contaminant (mg dry weight/kg body weight per day)
BW is the body weight of target receptor (kg)
F is the fraction of vegetation consumed
CR is the consumption rate (kg dry weight plant per day)

The toxicity reference value (TRV) provided for the surrogate receptor group (mammalian herbivore) for cadmium is 0.770 mg dry weight per kg of body weight per day (http://www.epa.gov/ecotox/ecossl/pdf/eco-ssl_cadmium.pdf). If we use the surrogate species (vole) with a body weight of 25 g (0.025 kg) and assume the diet is 100% plant tissue at a rate of 0.0875 kg plant/kg body weight (0.002188 kg/day) then we have the following:

$$C_{plant\,=}\,(0.770\ \text{mg/kg}\ \times 0.025\ \text{kg}) / (1 \times 0.002188\ \text{kg})$$

$$C_{plant\,=}\,8.80\ \text{mg/kg}$$

Based on these results, the mean cadmium concentration (6.8 mg kg-1) in plants grown in Lorain Harbor dredged material does not exceed an acceptable plant cadmium concentration considered acceptable to prevent adverse effects. The same calculation was applied to arsenic, chromium, copper, and lead using the TRVs shown in Table 18. Acceptable plant concentrations were all above the actual concentrations resulting from exposure of plants to Lorain Harbor dredged material.

The USEPA Eco-SSLs are currently pending for the remaining metals (mercury, nickel, silver and zinc) tested for Lorain Harbor dredged material. However, concentrations of mercury, nickel and zinc in plants grown in Lorain Harbor dredged material are not considered elevated and are typical of plant concentrations around the Great Lakes Area. Simmers et al. (1981) reported concentrations of metals in plants collected from natural marshes around Lakes Michigan and Erie. Mercury was reported to seldom exceed 0.02 mg kg^{-1} although some concentrations as high as 0.2 mg kg^{-1} were reported. Nickel concentrations in marsh plants ranged from <0.3 to as high as 14.1 mg kg^{-1} while zinc was reported as mean of 79 mg kg^{-1} with a maximum concentration of 317 mg kg^{-1}. Other metals reported were lead (6.07 mean, 85.20 max), copper (8.2 mean, 26.8 max), chromium (<0.025 to 33.23), cadmium (<0.0025 to 3.3) and arsenic (0.025 to 0.7). When metal content in plants exposed to Lorain Harbor dredged material is compared to the natural marsh values reported by Simmers, only cadmium is shown to be elevated.

7.4.3 Earthworm Growth and Uptake of Organic Contaminants

Initial (Day 0) and 28-day earthworm weights and counts are shown in Table 19. Mean lipid content of earthworms at the start of the test procedure was 19.3 mg kg^{-1}. The reduction in numbers and weight of earthworms after 28 days was similar in all materials including the laboratory control. Loss of earthworms in all test materials can be explained by death and decomposition but cause of death is uncertain. Stress or injury during handling and transfer to test media or competition for food are possible explanations. Worm tissues were analyzed for PAH compounds found to contain concentrations of chrysene, benzo(b)fluoranthene and benzo(k)fluoranthene in worms exposed to Lorain Harbor dredged material. However, concentrations were all near the detection limit as shown in Table 20 and remaining PAH compounds were not detectable at the method detection limit (MDL) shown. No PAH compounds were detected in earthworms exposed to the Lorain Reference soil.

The presence of low level PAH compounds in earthworms does not automatically constitute a significant concern. As with plant tissues, there are no regulatory limits for contaminant concentrations in earthworms or soil invertebrates as a food source to receptors. The implications of contaminant body burdens are evaluated based on the potential for adverse effects to predatory higher animals that may feed on earthworms and potentially bioaccumulate contaminants as a result. However, predicting potential impacts based on a food ingestion rates requires a TRV for PAH compounds and there is little consensus on such values. USACHPPM (2003) suggests an mammalian TRV (NOAEL-based) of 1 mg/kg/d for benzo(a)pyrene. Assuming the same TRV for other presumably less toxic PAH compounds we can apply the equation in section 7.4.2 for determining acceptable earthworm concentrations of PAH compounds. Using the earthworm to mammalian exposure route and assuming a shrew as a receptor (BW=0.25 kg) and a consumption rate (CR) of 0.005225 kg of earthworms/day, the earthworm concentration of benzo(a)pyrene would need to equal or exceed 4.785 mg kg^{-1}. Only chrysene, benzo(b) and benzo(k)fluoranthene were detected in earthworms exposed to Lorain Harbor dredged material and concentrations of each were three orders of magnitude below the calculated acceptable earthworm concentration. Measured uptake of PAH compounds by earthworms is not expected to have any impact on predatory receptors.

7.5 TIER III Conclusion

Contaminants in the Lorain Harbor CDF dredged material are below numerical criteria deemed suitable for beneficial uses. However, at this time the suitability for beneficial uses may not be determined acceptable by such comparisons alone. Tier III plant and earthworm bioassays were conducted on Lorain Harbor dredged material and compared to the Monkey Island Reference soil. Plant uptake of metals by *Cyperus esculentus* grown in dredged material from the Lorain Harbor CDF was not statistically higher than uptake from the Monkey Island Reference. Other plant species, such as trees, may increase the uptake of some metals while some species, such as fescues, can minimize uptake of metals. A lowering of pH over time may also increase metal uptake by plants. Management options to ensure conditions attributable to lower plant uptake of metals may include establishment of grasses, such as fine fescues, and monitoring of pH and subsequent liming to maintain pH levels above 6.5.

Earthworms exposed to Lorain Harbor dredged material and Monkey Island Reference soil were analyzed for PAHs. While uptake of only three PAH compounds were detected in earthworms exposed to Lorain Harbor dredged material none were detected in earthworms exposed to Monkey Island soil. Acceptable earthworm concentrations of benzo(a)pyrene were calculated using a TRV of 1.0 mg/kg of bodyweight and resulted in a value three orders of magnitude above earthworm PAH concentrations resulting from the Tier III bioassay. While limitations on earthworm concentrations of PAH compounds are not currently available, based on best judgment, the risk posed by low-level PAHs in Lorain Harbor dredged material would be insignificant under best management practices described below.

8.0 RECOMMENDATIONS FOR CDF BENEFICIAL USE AND MANAGEMENT

Based on the results of this evaluation it is recommended that beneficial uses of the CDF could include park or other recreational use. If fertilizer application is planned in the future as part of park or recreational use, it may be necessary to monitor fertilizer use and pH to maintain pH levels above 6.5 to minimize availability of metals. For minimizing human contact with dredged material a well-managed turf consisting of fine fescue or similar turf species is recommended. Use of these turf grass species in a near neutral pH will minimize plant uptake of metals.

The potential for uptake and mobilization of metals via trees was not specifically evaluated in this assessment, as tree roots may reach deeper sediments and soils than sampled and analyzed in this Tier III evaluation.   Furthermore, tree species tend to mobilize more metals to the surface via leaf fall and should be avoided if possible. Habitat that could be an attractive nuisance to any threatened and endangered species sensitive to contaminants or species considered a nuisance themselves should be avoided as well.

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FIGURES

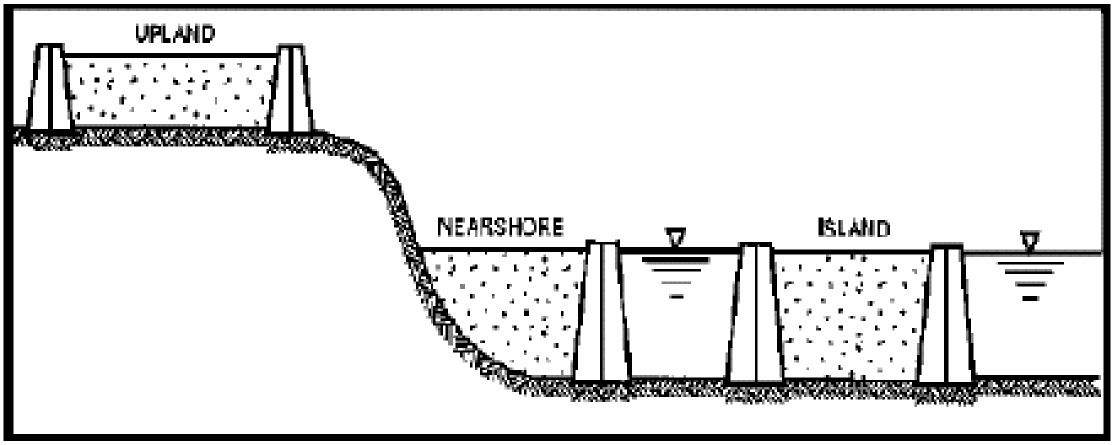


Figure 1: Schematic of upland, nearshore and island CDFs (after USACE/EPA 1992)

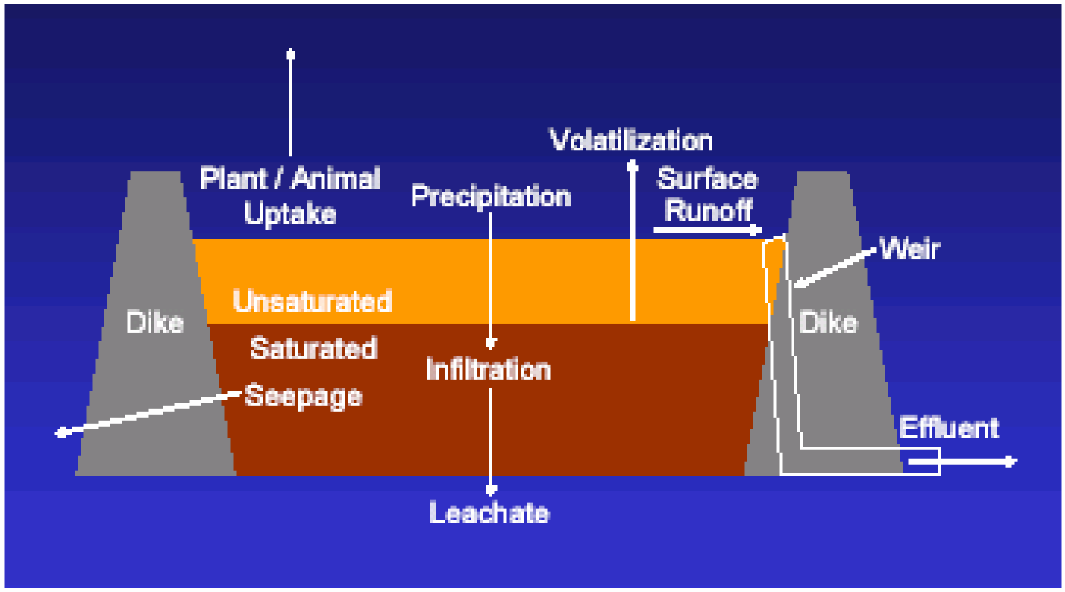
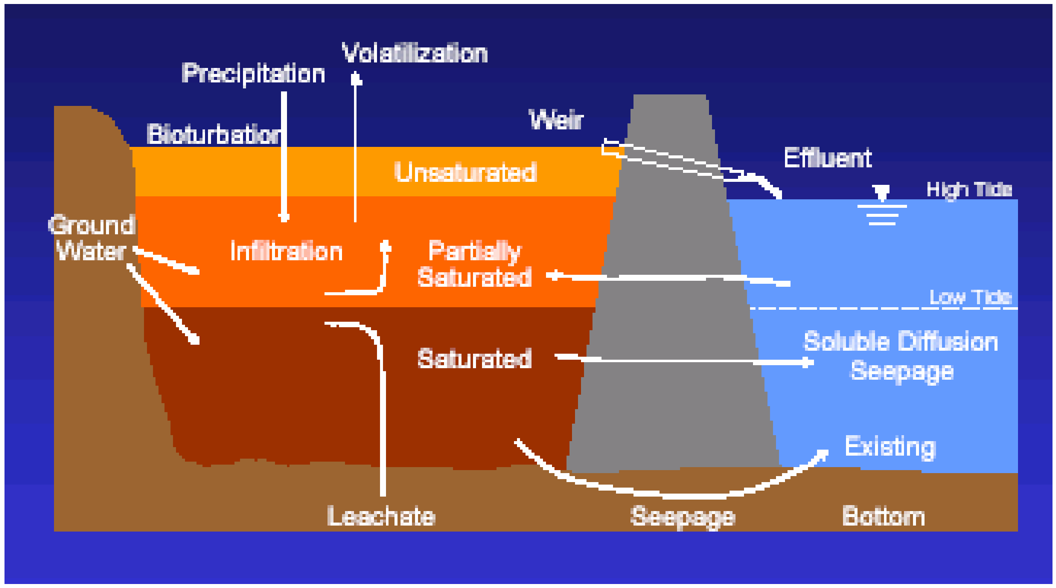


Figure 2: Schematic of contaminant migration pathways for upland CDFs (USACE 2003).



<u>Figure 3</u>: Schematic of contaminant migration pathways for nearshore CDFs (USACE 2003).

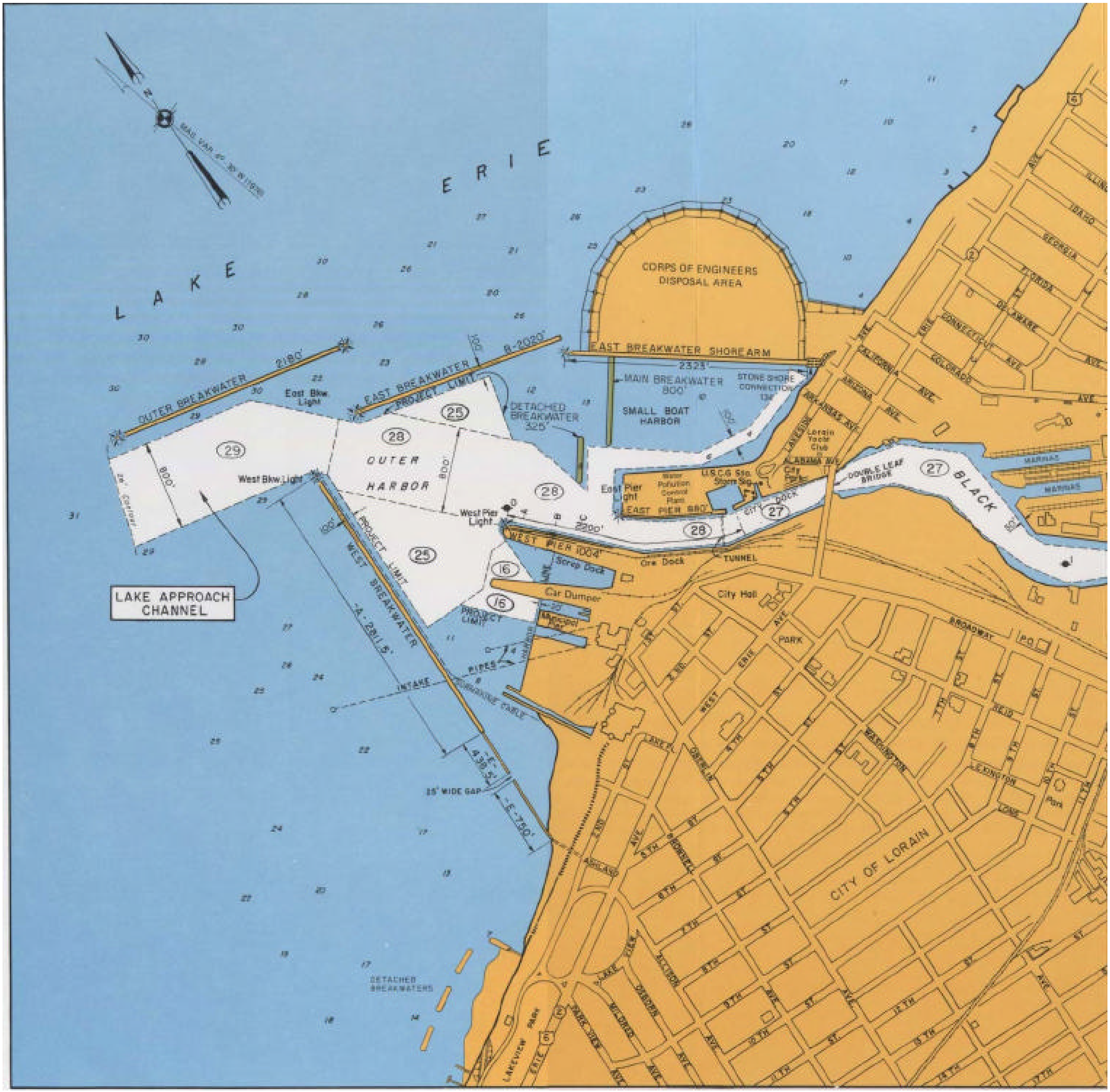
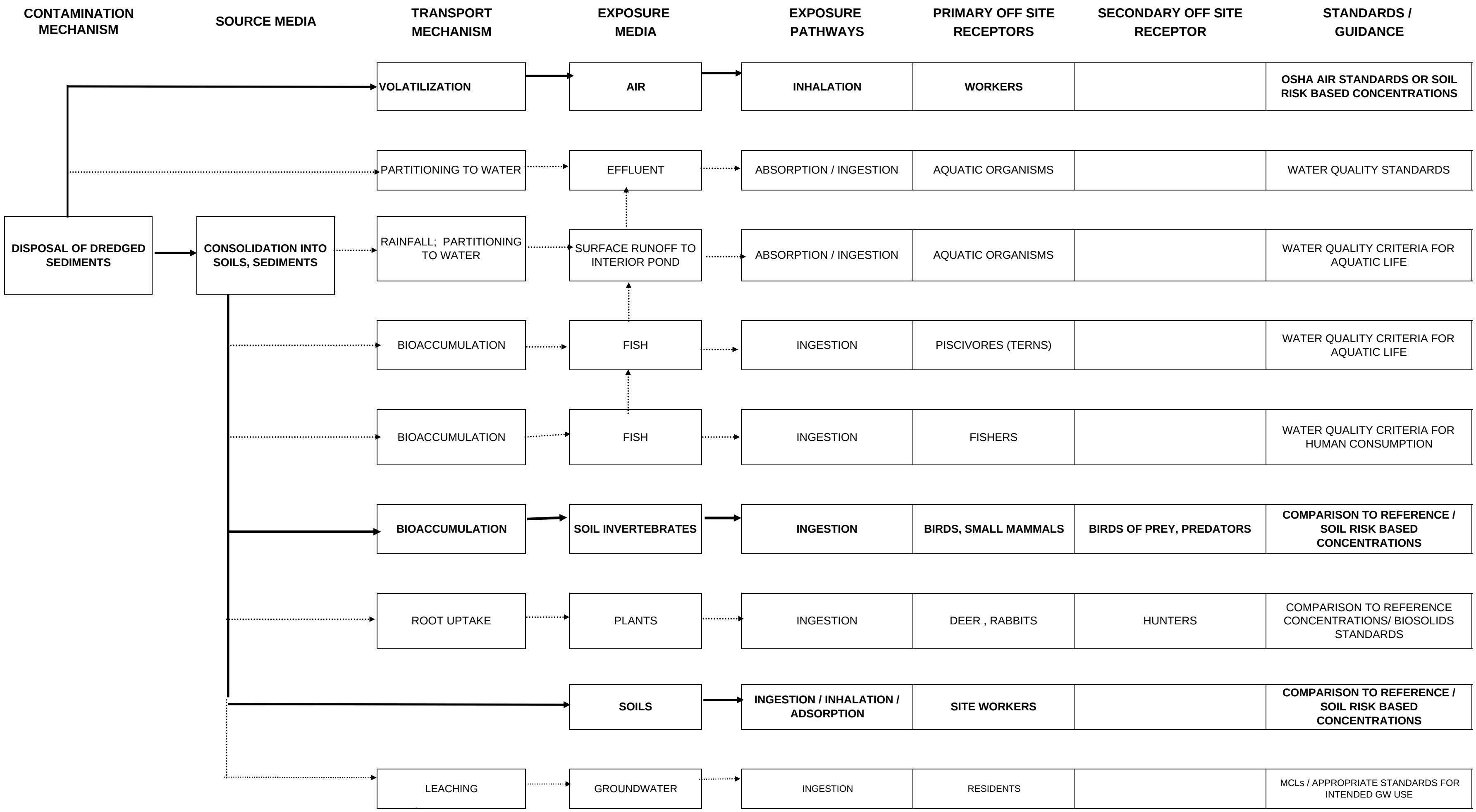


Figure 4: Lorain Harbor CDF Site Map

Figure 5. TIER 1 GRAPHIC CONCEPTUAL SITE MODEL ~ PATHWAYS FOR INITIAL EVALUATION OF LORAIN CONFINED DISPOSAL FACILITY



Notes:
Bold indicates the pathway is complete and should be evaluated for this CDF
Regular font and dashed arrows indicates that this pathway is incomplete and does not have to be evaluated for this CDF.

Pollutant	Monthly average concentration (milligrams per kilogram dry weight basis)
Arsenic	41
Cadmium	39
Copper	1,500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2,800

Figure 6. State of Ohio land application restrictions for sewage sludge (monthly average) http://www.epa.state.oh.us/dsw/rules/40-05.pdf.

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health

SUMMARY TABLES

Update 6.0
July 2006

Table 1. Canadian Soil Quality Guidelines (mg·kg^{-1}).

Substance	Year revised/ released[a]	Agricultural*		Residential/ parkland*		Commercial*		Industrial*	
		Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine
Arsenic (inorganic)	1997	12[b]		12[b]		12[b]		12[b]	
Barium	2003	750[c]		500[c]		2000[c]		2000[c]	
Benzene									
Surface[y]	2004	0.030[u, t]	0.0068[u, t]	0.030[u, t]	0.0068[u, t]	0.030[u, t]	0.0068[u, t]	0.030[u, t]	0.0068[u, t]
Subsoil[y]	2004	0.030[u, t]	0.0068[u, t]	0.030[u, t]	0.0068[u, t]	0.030[u, t]	0.0068[u, t]	0.030[u, t]	0.0068 [u, t]
Surface[x]	2004	0.0095[u, t]	0.0068[u, t]	0.0095[u, t]	0.0068[u, t]	0.030[u, t]	0.0068[u, t]	0.030[u, t]	0.0068 [u, t]
Subsoil[x]	2004	0.01[u, t]	0.0068[u, t]	0.011[u, t]	0.0068[u, t]	0.030[u, t]	0.0068[u, t]	0.030[u, t]	0.0068 [u, t]
Benzo*(a)*pyrene	1997	0.1[e]		0.7[f]		0.7[f]		0.7[f]	
Cadmium	1999	1.4[b]		10[g]		22[b]		22[b]	
Chromium									
Total chromium	1997	64[b]		64[b]		87[b]		87[b]	
Hexavalent chromium (VI)	1999	0.4[h]		0.4[h]		1.4[h]		1.4[h]	
Copper	1999	63[b]		63[b]		91[b]		91[b]	
Cyanide (free)	1997	0.9[b]		0.9[b]		8.0[b]		8.0[b]	
DDT (total)	1999	0.7[i]		0.7[i]		12[i, j]		12[i, j]	
Diisopropanolamine (DIPA)	2006	180[b]		180[b]		180[b]		180[b]	
Ethylbenzene									
Surface	2004	0.082[t]	0.018[u, t]	0.082[t]	0.018[u, t]	0.082[t]	0.018[u, t]	0.082[t]	0.018[u, t]
Subsoil	2004	0.082[t]	0.018[u, t]	0.082[t]	0.018[u, t]	0.082[t]	0.018[u, t]	0.082[t]	0.018[u, t]
Ethylene glycol	1999	960[k]		960[k]		960[k]		960[k]	
Lead	1999	70[b]		140[b]		260[b]		600[b]	
Mercury (inorganic)	1999	6.6[b]		6.6[b]		24[b]		50[b]	
Naphthalene	1997	0.1[d]		0.6[h]		22[h]		22[h]	
Nickel	1999	50[l]		50[l]		50[l]		50[l]	
Nonylphenol (and its ethyloxylates)	2002	5.7[p]		5.7[p]		14[p]		14[p]	
Pentachlorophenol	1997	7.6[b]		7.6[b]		7.6[b]		7.6[b]	
Phenol	1997	3.8[b]		3.8[b]		3.8[b]		3.8[b]	
Polychlorinated biphenyls (PCBs)	1999	0.5[m]		1.3[l]		33[l, j]		33[l, j]	
Polychlorinated dibenzo-*p*-dioxins/ dibenzofurans (PCDD/Fs)	2002	4 ng TEQ·kg^{-1} [q]		4 ng TEQ·kg^{-1} [q]		4 ng TEQ·kg^{-1} [r]		4 ng TEQ·kg^{-1} [s]	
Propylene glycol	2006	Insufficient information[v]		Insufficient information[v]		Insufficient information[v]		Insufficient information[v]	
Selenium	2002	1[b]		1[b]		3.9[b]		3.9[b]	

Continued

Figure 7. Canadian Environmental Quality Guidelines (http://www.ccme.ca/assets/pdf/ceqg_soil_summary_table_v6_e.pdf).

Sulfolane	2006	0.8[b]		0.8[b]		0.8[b]		0.8[b]	
Tetrachloroethylene	1997	0.1[e]		0.2[f]		0.5[f]		0.6[f]	
Thallium	1999	1[n]		1[o]		1[o]		1[o]	
Toluene									
Surface	2004	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]
Subsoil	2004	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]
Trichloroethylene	2006	0.01[b,u]		0.01[b,u]		0.01[b,u]		0.01[b,u]	
Vanadium	1997	130[l]		130[l]		130[i]		130[i]	
Xylenes									
Surface	2004	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]
Subsoil	2004	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]
Zinc	1999	200[l]		200[l]		360[l]		360[l]	

Notes: SQG_E = soil quality guideline for environmental health; SQG_{HH} = soil quality guideline for human health.

* For guidelines derived prior to 2004, differentiation between soil texture (coarse/fine) is not applicable.

[a]Guidelines released in 1997 were originally published in the working document entitled "Recommended Canadian Soil Quality Guidelines" (CCME 1997) and have been revised, edited, and reprinted here. Guidelines revised/released in 1999 are published here for the first time (see Table 2).

[b]Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_E. Therefore the soil quality guideline is the lower of the two and represents a fully integrated de novo guideline for this land use, derived in accordance with the soil protocol (CCME 1996). The corresponding interim soil quality criterion (CCME 1991) is superseded by the soil quality guideline.

[c]Data are insufficient/inadequate to calculate an SQG_{HH}, a provisional SQG_{HH}, an SQG_E, or a provisional SQG_E. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.

[d]Data are sufficient and adequate to calculate only a provisional SQG_E. It is greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.

[e]Data are sufficient and adequate to calculate an SQG_{HH} and a provisional SQG_E. Both are greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.

[f]Data are sufficient and adequate to calculate an SQG_{HH} and a provisional SQG_E. Both are less than corresponding interim soil quality criterion (CCME 1991). Therefore the soil quality guideline supersedes the interim soil quality criterion for this land use.

[g]The soil–plant–human pathway was not considered in the guideline derivation. If produce gardens are present or planned, a site-specific objective must be derived to take into account the bioaccumulation potential (e.g., adopt the agricultural guideline as objective). The off-site migration check should be recalculated accordingly.

[h]Data are sufficient and adequate to calculate only a provisional SQG_E, which is less than the existing interim soil quality criterion (CCME 1991). Therefore the soil quality guideline supersedes the interim soil quality criterion for this land use.

[i]Data are sufficient and adequate to calculate only an SQG_E. An interim soil quality criterion (CCME 1991) was not established for this land use, therefore the SQG_E becomes the soil quality guideline.

[j]In site-specific situations where the size and/or the location of commercial and industrial land uses may impact primary, secondary, or tertiary consumers, the soil and food ingestion guideline is recommended as the SQG_E.

[k]Data are sufficient and adequate to calculate only a provisional SQG_E.

[l]Data are sufficient and adequate to calculate only an SQG_E, which is less than the interim soil quality criterion (CCME 1991) for this land use. Therefore the SQG_E becomes the soil quality guideline, which supersedes the interim soil quality criterion for this land use.

[m]Data are sufficient and adequate to calculate only an SQG_E, which is greater than the interim soil quality criterion (CCME 1991) for this land use. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.

[n]Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_E. The provisional SQG_{HH} is equal to the SQG_E and to the existing interim soil quality criterion (CCME 1991) and thus becomes the soil quality guideline, which supersedes the interim soil quality criterion for this land use.

[o]Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_E. The provisional SQG_{HH} is less than the SQG_E and thus becomes the soil quality guideline for this land use.

[p]Data are sufficient and adequate to calculate only an SQG_E. An interim soil quality criterion (CCME 1991) was not established for these substances, therefore, the SQG_E becomes the soil quality guideline.

[q]Data are sufficient and adequate to calculate only a provisional SQG_{HH}, which is less than the existing interim soil quality criterion (CCME 1991). Thus the provisional SQG_{HH} becomes the soil quality guideline, which supersedes the interim soil quality criterion for this land use.

[r]Data are sufficient and adequate to calculate only a provisional SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use, therefore the provisional SQG_{HH} becomes the soil quality guideline.

[s]Data are sufficient and adequate to calculate only an SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use, therefore the SQG_{HH} becomes the soil quality guideline.

[t]Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_E. Therefore the soil quality guideline is the lower of the two and represents a fully

Figure 7. Continued.

integrated *de novo* guideline for this land use.
[u]This guideline value may be less than the common limit of detection in some jurisdictions. Contact jurisdictions for guidance.
[v]Data are sufficient and adequate to calculate only a preliminary SQG_{FWAL} (Soil Quality Guideline for freshwater aquatic life). This value is 6,210 $mg \cdot kg^{-1}$. See accompanying factsheet for further information.
[w]10^{-5} Incremental Risk
[x]10^{-6} Incremental Risk

References

CCME (Canadian Council of Ministers of the Environment). 1991. Interim Canadian environmental quality criteria for contaminated sites. CCME, Winnipeg.

———. 1996. A protocol for the derivation of environmental and human health soil quality guidelines. CCME, Winnipeg. [A summary of the protocol appears in Canadian environmental quality guidelines, Chapter 7, Canadian Council of Ministers of the Environment, 1999, Winnipeg.]

———. 1997. Recommended Canadian soil quality guidelines. CCME, Winnipeg.

Figure 7. Concluded

Figure 8. Plant growth in Lorain Harbor CDF dredged material.

Figure 9. Plant growth in Monkey Island Reference material.

TABLES

<u>Table 1</u>: Sixteen Priority Pollutant PAHs

Acenaphthene	Acenaphthylene
Anthracene	Benzo(a)anthracene
Benzo(a)pyrene	Benzo(b)fluoranthene
Benzo(ghi)perylene	Benzo(k)fluoranthene
Chrysene	Dibenzo(a,h)anthracene
Fluoranthene	Fluorene
Indeno(1,2,3-cd)pyrene	Naphthalene
Phenanthrene	Pyrene

<u>Table 2</u>: Priority Pollutant Metals

Antimony	Arsenic
Beryllium	Cadmium
Chromium	Copper
Iron	Lead
Mercury	Nickel
Selenium	Silver
Thallium	Zinc

Table 3: Comparison of Average Concentrations of Constituents Outside of the Dike to Background Lake Data

Constituent	Average Concentration Outside Dike	Average Concentration of Background Lake Water
	µg/L	µg/L
Metals		
Antimony	<2.2E+00	<2.2E+00
Arsenic	<1.20E+00	<1.20E+00
Beryllium	<1.00E+00	<1.00E+00
Cadmium	<5.00E-01	<5.00E-01
Chromium	<4.00E+00	<4.00E+00
Copper	6.57E+00	6.50E+00
Lead	3.04E+00	2.60E+00
Mercury	6.00E-01	2.33E-01
Nickel	9.43E+00	6.67E+00
Selenium	<1.60E+00	<1.60E+00
Silver	<5.00E+00	5.33E+00
Thallium	4.29E-01	2.33E-01
Zinc	7.67E+00	4.00E+00

Exceeds Background Lake average concentration.

Table 4. Comparison of Average Metal Concentrations with Reference Concentrations

All units are in ppm

Metals	Average Concentration in Soils	Ohio EPA Reference Values ECBP	Ohio EPA Reference Values EOLP	Ohio EPA Statewide Reference Values
Antimony	4.31E-01	9.20E-01	1.30E+00	
Arsenic	7.08E+00	1.80E+01	2.50E+01	
Beryllium	2.96E-01			8.00E-01
Cadmium	2.30E+01	9.00E-01	7.90E-01	
Chromium	2.02E+01	4.00E+01	2.90E+01	
Copper	3.01E+01	3.40E+01	3.20E+01	
Lead	2.68E+01			4.70E+01
Mercury	6.46E-02			1.20E-01
Nickel	2.28E+01	4.20E+01	3.30E+01	
Silver	6.38E-01			4.30E-01
Thallium	4.62E-01			4.70E+00
Vanadium	1.37E+01			4.00E+01
Zinc	1.12E+02	1.60E+02	1.60E+02	

Ohio EPA Sediment Reference Values-Ohio Ecological Risk Assessment Guidance Document. February 2003.

ECBP Eastern Corn Belt Plains area of Ohio sediment reference value.
EOLP Erie/Ontario Lake Plains area of Ohio sediment reference value.

Exceeds Ohio ECBP reference value.
Exceeds Ohio EOLP reference value.
Exceeds both Ohio ECBP and EOLP reference values.
Exceeds Ohio Statewide reference value.

Table 5: Comparison of detected constituents with USEPA Region IX Preliminary Remediation Goals

All units are ppm Constituent	USEPA Region IX PRG Residential	USEPA Region IX PRG Industrial	Maximum Detection Soils	Average Concentration Soils
VOCs				
Dichlorodifluoromethane	9.39E+01	3.08E+02	7.10E-02	2.53E-02
PAHs				
Acenaphthene	3.70E+03	2.90E+04	3.10E+00	5.28E-01
Acenaphthylene			9.60E+00	1.06E+00
Anthracene	2.19E+04	1.00E+05	3.30E+01	3.30E+00
Benzo(a)anthracene	6.21E-01	2.10E+00	5.90E+01	4.52E+00
Benzo(a)pyrene	6.21E-02	2.10E-01	2.70E+01	2.30E+00
Benzo(b)flouranthene	6.21E-01	2.10E+00	4.00E+01	4.00E+00
Benzo(k)flouranthene	6.20E+00	2.10E+01	5.70E+00	9.02E-01
Benzo (g,h,I)perylene			1.50E+01	1.60E+00
Chrysene	6.21E+01	2.10E+02	3.30E+01	3.43E+00
Dibenz(a,h)anthracene	6.20E-02	2.10E-01	4.80E+00	5.71E-01
Flouranthene	2.29E+03	2.20E+04	8.10E+01	7.21E+00
Fluorene	2.70E+03	2.60E+04	2.30E+01	1.82E+00
Indeno(1,2,3-cd)Pyrene	6.21E-01	2.10E+00	2.10E+01	2.01E+00
2-Methylnaphthalene			3.10E+00	5.28E-01
Naphthalene	5.60E+01	1.90E+02	4.50E+00	5.83E-01
Phenanthrene			7.90E+01	6.48E+00
Pyrene	2.32E+03	2.90E+04	6.60E+01	5.55E+00
Total PAHs			5.08E+02	4.64E+01
BNAs				
Dibenzofuran	2.90E+02	3.10E+03	1.20E+01	1.24E+00
bis(2-ethylhexyl)phthalate	3.5E+01	1.2E+02	4.74E-01	2.43E-01
PCBs				
Aroclor-1254	2.2E-01	7.4E-01	6.60E-01	2.35E-01
Metals				
Antimony	3.10E+01	4.10E+02	<7.5E-01	<4.31E-01
Arsenic	3.90E-01	1.60E+00	1.00E+01	7.08E+00
Beryllium	1.50E+02	1.90E+03	8.00E-01	2.96E-01
Cadmium	3.70E+01	4.50E+02	2.14E+02	2.30E+01
Chromium	2.10E+02	4.50E+02	5.50E+01	2.02E+01
Copper	3.10E+03	4.10E+04	6.30E+01	3.01E+01
Lead	4.00E+02	7.50E+02	5.60E+01	2.68E+01
Mercury	2.30E+01	3.10E+02	1.30E-01	6.46E-02
Nickel	1.60E+03	2.00E+04	3.90E+01	2.28E+01
Selenium	3.90E+02	5.11E+03	<8.00E-01	<5.62E-01
Silver	3.91E+02	5.11E+03	5.70E+00	6.38E-01
Thallium	5.20E+00	6.70E+01	7.00E-01	4.62E-01
Vanadium	5.50E+02	7.20E+03	2.40E+01	1.37E+01
Zinc	2.30E+04	1.00E+05	2.34E+02	1.12E+02
Other				
Dioxin (2,3,7,8-TCDD)	3.9E-06	1.6E-05	7.22.E-07	
Cyanide	1.1E+01	3.5E+01	8.29E-01	5.63E-01
(green)	Exceeds residential PRG			
(pink)	Exceeds industrial PRG			

Table 6: Comparison of detected constituents with USEPA Biosolids Rule 503

All units are ppm

Constituent	Biosolids Limits	Soil Concentration Limits	Maximum Detection, Soils	Average Detection, Soils
PAHs				
Acenaphthene	NE	NE	2.00E+01	1.91E+00
Acenapthylene	NE	NE	9.60E+00	1.06E+00
Anthracene	NE	NE	3.30E+01	3.33E+00
Benzo(a)anthracene	NE	NE	5.90E+01	4.52E+00
Benzo(a)pyrene	1.50E+01	NE	2.70E+01	2.32E+00
Benzo(b)flouranthene	NE	NE	4.00E+01	4.00E+00
Benzo(k)fluoranthene	NE	NE	5.70E+00	9.02E-01
Benzo (g,h,I)perylene	NE	NE	1.50E+01	1.60E+00
Chrysene	NE	NE	3.30E+01	3.43E+00
Dibenz(a,h)anthracene	NE	NE	4.80E+00	5.71E-01
Flouranthene	NE	NE	8.10E+01	7.21E+00
fluorene	NE	NE	2.30E+01	1.82E+00
Indeno(1,2,3-cd)Pyrene	NE	NE	2.10E+01	2.01E+00
2-Methlynaphthalene	NE	NE	3.10E+00	5.28E-01
Naphthalene	NE	NE	4.50E+00	5.83E-01
Phenanthrene	NE	NE	7.90E+01	6.48E+00
Pyrene	NE	NE	6.60E+01	5.55E+00
BNAs				
dibenzofuran	NE	NE	1.20E+01	1.24E+00
bis(2-ethylhexyl)phthalate	NE	NE	4.74E-01	2.43E-01
PCBs				
Aroclor-1254	4.60E+00	NE	6.60E-01	2.35E-01
Metals				
Antimony	NE	NE	<7.50E-01	<4.31E-01
Arsenic	4.10E+01	2.05E+01	1.00E+01	7.08E+00
Beryllium	NE	NE	8.00E-01	2.96E-01
Cadmium	3.90E+01	1.95E+01	2.14E+02	2.30E+01
Chromium	NE	NE	5.50E+01	2.02E+01
Copper	1.50E+03	7.50E+02	6.30E+01	3.01E+01
Lead	3.00E+02	1.50E+02	5.60E+01	2.68E+01
Mercury	1.70E+01	8.50E+00	1.30E-01	6.46E-02
Nickel	4.20E+02	2.10E+02	3.90E+01	2.28E+01
Selenium	1.00E+02	5.00E+01	<8.00E-01	<5.62E-01
Silver	NE	NE	5.70E+00	6.38E-01
Thallium	NE	NE	7.00E-01	4.62E-01
Vanadium	NE	NE	2.40E+01	1.37E+01
Zinc	2.80E+03	1.40E+03	2.34E+02	1.12E+02

NE Not Established

Exceeds criteria

Table 7: Comparison of Outside Dike Water and Soil Leachate Concentratons with EPA Environmental Water Quality Criteria for Aquatic Organisms

Constituent	CCC	CMC	Maximum Outside Dike Water Detection	Average Outside Dike Water Detection	Maximum Background Lake Water Detection	Average Background Lake Water Detection	Maximum Soil Leachate Detection	Average Soil Leachate Detection
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
VOCs								
Dichlorodifluoromethane	NA	NA	<5.0E-01	<5.0E-01	<5.0E-01	<5.0E-01	<5.0E-01	<5.0E-01
Metals								
Antimony	NA	NA	<2.2E+00	<2.2E+00	<2.2E+00	<2.2E+00	7.00E+00	2.22E+00
Arsenic	1.50E+02	3.40E+02	<1.2E+00	<1.2E+00	<1.2E+00	<1.2E+00	4.30E+01	5.77E+00
Beryllium	NA	NA	<1.0E+00	<1.0E+00	<1.0E+00	<1.0E+00	<1.0E+00	<1.0E+00
Cadmium	2.50E-01	2.00E+00	<5.0E-01	<5.0E-01	<5.0E-01	<5.0E-01	1.52E+00	3.10E-01
Chromium	7.40E+01	5.70E+02	<4.0E+00	<4.0E+00	<4.0E+00	<4.0E+00	1.30E+01	3.85E+00
Copper	9.00E+00	1.30E+01	1.10E+01	6.57E+00	1.10E+01	6.50E+00	7.40E+01	9.23E+00
Lead	2.50E+00	6.50E+01	3.20E+00	3.04E+00	3.00E+00	2.60E+00	2.05E+01	3.20E+00
Mercury	7.70E-01	1.40E+00	1.90E+00	6.00E-01	3.00E-01	2.33E-01	<3.00E-01	<3.00E-01
Nickel	5.20E+01	4.70E+02	1.40E+01	9.43E+00	1.00E+01	6.67E+00	3.00E+00	2.85E+00
Selenium	NA	5.00E+00	<1.6E+00	<1.6E+00	<1.6E+00	<1.6E+00	1.70E+00	8.69E-01
Silver	NA	3.20E+00	<5.0E+00	<5.0E+00	1.10E+01	5.33E+00	1.90E+01	3.77E+00
Thallium	NA	NA	7.00E-01	4.29E-01	4.00E-01	2.33E-01	<3.0E+00	<3.0E+00
Zinc	1.20E+02	1.20E+02	1.10E+01	7.67E+00	5.00E+00	4.00E+00	9.00E+01	2.98E+01
PAHs								
Acenaphthene	*	*	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Acenaphthylene	*	*	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Anthracene	*	*	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Benzo(a)anthracene	*	*	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00
Benzo(b)flouranthene	*	*	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00
Benzo(k)flouranthene	*	*	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00
Benzo (g,h,I)perylene	*	*	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00
Benzo(a)pyrene	*	*	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00
Chrysene	*	*	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00
Dibenz(a,h)anthracene	*	*	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00
Flouranthene	*	*	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Fluorene	*	*	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00
Indeno(1,2,3-cd)Pyrene	*	*	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00
2-Methylnaphthalene	*	*	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Naphthalene	*	*	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Phenanthrene	*	*	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Pyrene	*	*	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00
BNAs								
Dibenzofuran	*	*	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
bis(2-ethylhexyl)phthalate	*	*	no data	no data	no data	no data	no data	no data
PCBs								
Aroclor-1254	0.014**	*	<1.00E-01	<1.00E-01	<1.00E-01	<1.00E-01	<1.00E-01	<1.00E-01

CMC-criteria maximum concentration; National Recommended Water Quality Criteria (Section 304(a))

CCC-criteria continuous concentration; National Recommended Water Quality Criteria (Section 304(a))

* Only human health surface water quality criteria exist, but not established for protection of aquatic life

NA Criteria not available.

** This CCC is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

Exceeds CMC Criteria.

Exceeds CCC Criteria.

Table 7a: Comparison of Sediment Concentrations with Consensus Threshold and Probable Effects Concentrations

Constituent	Consensus TEC (ppm DW)	Consensus PEC (ppm DW)	Maximum Sediment Detection (ppm)	Average Sediment Concentration (ppm)
PAHs				
Acenaphthene	NA	NA	3.10E+00	5.28E-01
Acenaphthylene	NA	NA	9.60E+00	1.06E+00
Anthracene	5.72E-02	8.45E-01	3.30E+01	3.30E+00
Benzo(a)anthracene	1.08E-01	1.05E+00	5.90E+01	4.52E+00
Benzo(a)pyrene	1.50E-01	1.45E+00	2.70E+01	2.30E+00
Benzo(b)flouranthene	NA	NA	4.00E+01	4.00E+00
Benzo(k)flouranthene	NA	NA	5.70E+00	9.02E-01
Benzo(g,h,I) perylene	NA	NA	1.50E+01	1.60E+00
Chrysene	1.66E-01	1.29E+00	3.30E+01	3.43E+00
Flouranthene	4.23E-01	2.23E+00	8.10E+01	7.21E+00
Fluorene	7.74E-02	5.36E-01	2.30E+01	1.82E+00
Naphthalene	1.76E-01	5.61E-01	4.50E+00	5.83E-01
Indeno(1,2,3-cd)Pyrene	NA	NA	2.10E+01	2.01E+00
Phenanthrene	2.04E-01	1.17E+00	7.90E+01	6.48E+00
Pyrene	1.95E-01	1.52E+00	6.60E+01	5.55E+00
Total PAHs	1.61E+00	2.28E+01	5.00E+02	4.53E+01

NA	No sediment effects concentration available
	Exceeds Threshold Effect Concentration
	Exceeds Probable Effect Concentration

Table 8: Comparison of Outside Dike Water and Soil Leachate Concentratons with EPA Environmental Water Quality Criteria for Human Health

Constituent	Human Health - Consumption of Organisms only µg/L	Maximum Outside Dike Water Detection µg/L	Average Outside Dike Water Detection µg/L	Maximum Background Lake Water Detection µg/L	Average Background Lake Water Detection µg/L	Maximum Soil Leachate Detection µg/L	Average Soil Leachate Detection µg/L
VOCs							
Dichlorodifluoromethane	NA	<5.0E-01	<5.0E-01	<5.0E-01	<5.0E-01	<5.0E-01	<5.0E-01
Metals							
Antimony	6.40E+02	<2.2E+00	<2.2E+00	<2.2E+00	<2.2E+00	7.00E+00	2.22E+00
Arsenic	1.40E-01	<1.2E+00	<1.2E+00	<1.2E+00	<1.2E+00	4.30E+01	5.77E+00
Beryllium	NA	<1.0E+00	<1.0E+00	<1.0E+00	<1.0E+00	<1.0E+00	<1.0E+00
Cadmium	NA	<5.0E-01	<5.0E-01	<5.0E-01	<5.0E-01	1.52E+00	3.10E-01
Chromium	NA	<4.0E+00	<4.0E+00	<4.0E+00	<4.0E+00	1.30E+01	3.85E+00
Copper	NA	1.10E+01	6.57E+00	1.10E+01	6.50E+00	7.40E+01	9.23E+00
Lead	NA	3.20E+00	3.04E+00	3.00E+00	2.60E+00	2.05E+01	3.20E+00
Mercury	NA	1.90E+00	6.00E-01	3.00E-01	2.33E-01	<3.00E-01	<3.00E-01
Nickel	4.60E+03	1.40E+01	9.43E+00	1.00E+01	6.67E+00	3.00E+00	2.85E+00
Selenium	4.20E+03	<1.6E+00	<1.6E+00	<1.6E+00	<1.6E+00	1.70E+00	8.69E-01
Silver	NA	<5.0E+00	<5.0E+00	1.10E+01	5.33E+00	1.90E+01	3.77E+00
Thallium	4.70E-01	7.00E-01	4.29E-01	4.00E-01	2.33E-01	<3.0E+00	<3.0E+00
Zinc	2.60E+04	1.10E+01	7.67E+00	5.00E+00	4.00E+00	9.00E+01	2.98E+01
PAHs							
Acenaphthene	NA	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Acenaphthylene	NA	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Anthracene	4.00E+04	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Benzo(a)anthracene	1.80E-02	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00
Benzo(b)flouranthene	1.80E-02	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00
Benzo(k)flouranthene	1.80E-02	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00
Benzo (g,h,I)perylene	NA	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00
Benzo(a)pyrene	1.80E-02	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00	<4.00E+00
Chrysene	1.80E-02	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00
Dibenzo(a,h)anthracene	1.80E-02	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00
Flouranthene	1.40E+02	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Fluorene	5.30E+03	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00
Indeno(1,2,3-cd)Pyrene	1.80E-02	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00	<5.00E+00
2-Methylnaphthalene	NA	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Naphthalene	NA	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Phenanthrene	NA	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
Pyrene	4.00E+03	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00	<3.00E+00
BNAs							
Dibenzofuran	NA	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00	<2.00E+00
bis(2-ethylhexyl)phthalate	2.20E+00	no data	no data	no data	no data	no data	no data
PCBs							
Aroclor-1254	6.40E-05	<1.00E-01	<1.00E-01	<1.00E-01	<1.00E-01	<1.00E-01	<1.00E-01

NA Criteria not available.

Exceeds Human Health Consumption Criteria.

Table 9 **Times Beach Oxidized Soil vs. Lorain Harbor CDF Oxidized Soil PAH Results**

Times Beach 2001 Oxidized Soil Testing Results (units are in ppm)

Parameter	T-1 0-28	T-2 0-15	T-3 0-18	T-4 0-18	T-5 0-18	T-6 0-12
Naphthalene	0.73	0.83	0.56	0.22	1.33	0.98
Acenaphthylene	0.20	0.20	0.16	0.25	0.28	0.50
Acenaphthene	0.08	0.15	0.12	0.55	0.31	0.34
Fluorene	0.22	0.10	0.79	0.25	0.27	0.30
Phenanthrene	0.55	0.96	0.61	0.52	1.30	1.66
Anthracene	0.32	0.39	0.30	0.35	0.56	0.90
Fluoranthene	0.73	1.18	0.72	0.63	1.04	2.71
Pyrene	0.64	0.95	0.56	0.53	0.63	1.90
Benzo(a)Anthracene	0.71	0.81	0.58	0.43	0.71	2.24
Chrysene	0.73	0.79	0.56	0.38	0.71	1.91
Benzo(b)Fluoranthene	1.08	1.16	0.90	0.57	1.57	3.05
Benzo(k)Fluoranthene	0.43	0.39	0.32	0.21	0.44	1.25
Benzo(a)Pyrene	0.86	1.02	0.74	0.52	1.30	2.79
Indeno(1,2,3-cd)Pyrene	0.70	0.69	0.47	0.28	0.83	1.61
Dibenzo(a,h)Anthracene	0.22	0.23	0.24	0.09	0.34	0.29
Benzo(ghi)Perylene	0.84	0.81	0.52	0.31	0.82	1.71
Total PAH (ppm)	9.02	10.66	8.14	6.07	12.44	24.13
TOC	20,700	15,000	11,500	15,700	40,900	33,100

PAH		
min	max	average
6.07	24.13	11.74

TOC		
min	max	average
11,500	40,900	22,817

Lorain 1999 Oxidized Soil Testing Results (units are in ppm)

	BCLDF 8	BCLDF 9	BCLDF 11	BCLDF 10	BCLDF 12	BCLDF 13	LCDF-1	LCDF-2	LCDF-3
Parameter	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
PAHs									
2-Methylnaphthalene	0.29	3.10	0.29	0.29	0.28	0.25			
Acenaphthene	0.82	20.00	0.29	0.29	0.28	0.25			
Acenaphthylene	0.29	9.60	0.29	0.29	0.28	0.25			
Anthracene	1.60	33.00	3.50	0.52	0.28	0.25			
Benzo(a)Anthracene	1.90	59.00	2.90	0.88	0.42	0.38	0.16	0.06	0.01
Benzo(a)Pyrene	1.20	27.00	1.70	0.51	0.28	0.25	0.27	0.18	0.16
Benzo(b)Fluoranthene	1.50	40.00	2.00	0.55	0.56	0.05	0.00	0.00	0.00
Benzo(ghi)Perylene	0.70	15.00	0.70	0.70	0.65	0.60	0.25	0.15	0.12
Benzo(k)Fluoranthene	0.55	5.70	0.55	0.55	0.55	0.50	0.01	0.01	0.01
Chrysene	1.90	33.00	2.80	9.10	0.42	0.38	0.17	0.08	0.01
Dibenzo(a,h)Anthracene	0.70	4.80	0.29	0.29	0.28	0.25	0.01	0.01	0.01
Fluoranthene	6.10	81.00	7.70	3.00	0.28	0.25	0.24	0.13	0.05
Fluorene	0.44	23.00	0.88	0.44	0.42	0.38	0.02	0.01	0.00
Indeno(1,2,3-cd)Pyrene	0.70	21.00	0.70	0.70	0.67	0.60	0.25	0.18	0.16
Naphthalene	0.85	4.50	0.29	0.29	0.28	0.25	0.08	0.01	0.01
Phenanthrene	6.00	79.00	6.40	2.10	0.28	0.25	0.13	0.06	0.01
Pyrene	4.10	66.00	5.20	1.50	0.42	0.38	0.18	0.10	0.04
Total PAH	29.64	524.70	36.48	22.00	6.56	5.50	1.77	0.99	0.60
TOC	2,270	2,980	5,950	4,120	1,310	871	31,800	26,600	27,500

PAH		
min	max	average
0.60	524.70	69.80

TOC		
min	max	average
871	32,800	11,489

Table 10 **Times Beach Reduced Soil vs. Lorain Harbor CDF Reduced Soil PAH Results**

Times Beach 2001Reduced Soil Testing Results (units are in ppm [dry weight])

Parameter	T-2 15-36	T-3 18-27	T-4 18-30	T-6 12-30	T-7 10-30	T-8 12-36
Naphthalene	1.13	0.09	2.29	4.72	7.84	15.80
Acenaphthylene	0.22	0.22	0.19	0.27	3.05	3.26
Acenaphthene	0.11	0.22	0.98	2.47	5.07	4.46
Fluorene	0.07	0.22	0.68	1.71	3.05	1.17
Phenanthrene	0.55	0.09	2.74	0.28	3.55	7.53
Anthracene	0.29	0.22	1.84	5.14	4.82	11.20
Fluoranthene	0.60	0.22	1.64	3.83	1.71	3.26
Pyrene	0.55	0.22	0.79	2.34	1.67	1.66
Benzo(a)Anthracene	0.48	0.07	1.05	1.73	3.05	3.26
Chrysene	0.50	0.06	0.82	1.65	3.05	3.26
Benzo(b)Fluoranthene	0.79	0.13	1.08	1.42	3.05	3.26
Benzo(k)Fluoranthene	0.25	0.22	0.49	0.64	3.05	3.26
Benzo(a)Pyrene	0.63	0.11	0.90	1.15	3.05	3.26
Indeno(1,2,3-cd)Pyrene	0.37	0.09	0.54	0.58	3.05	3.26
Dibenzo(a,h)Anthracene	0.22	0.22	0.24	0.28	3.05	3.26
Benzo(ghi)Perylene	0.45	0.09	0.61	0.65	3.05	3.26
Total PAH (ppm)	7.19	2.47	16.88	28.85	55.11	74.37
TOC (ppm)	11,700	6,760	20,600	33,800	55,500	45,400

PAH		
min	max	average
2.47	74.37	30.81

TOC		
min	max	average
6,760	55,500	28,960

Lorain Reduced Soil Testing Results (units are in ppm)

Parameter	BCLDF 1	BCLDF 2	BCLDF 3	BCLDF 4	BCLDF 5	BCLDF 7
PAHs	Soil	Soil	Soil	Soil	Soil	Soil
2-Methylnaphthalene	0.39	0.33	0.33	0.33	0.33	0.33
Acenaphthene	0.94	0.33	0.33	0.33	0.33	0.33
Acenaphthylene	0.76	0.33	0.33	0.33	0.33	0.33
Anthracene	1.50	1.00	0.33	0.33	0.33	0.33
Benzo(a)Anthracene	2.40	2.30	0.38	0.38	0.375	0.375
Benzo(a)Pyrene	2.50	1.50	0.33	0.33	0.33	0.33
Benzo(b)Fluoranthene	2.10	1.90	0.67	0.67	0.665	0.665
Benzo(ghi)Perylene	2.40	0.80	0.80	0.80	0.8	0.8
Benzo(k)Fluoranthene	2.00	0.67	0.67	0.67	0.665	0.665
Chrysene	2.10	2.10	0.50	0.50	0.83	0.5
Dibenzo(a,h)Anthracene	0.51	0.33	0.33	0.33	0.33	0.33
Fluoranthene	5.80	4.90	1.50	1.50	1.9	0.76
Fluorene	0.58	0.50	0.50	0.50	0.5	0.5
Indeno(1,2,3-cd)Pyrene	2.40	0.80	0.80	0.80	0.8	0.8
Naphthalene	0.39	0.73	0.33	0.33	0.33	0.33
Phenanthrene	3.20	2.90	0.99	0.75	0.99	0.33
Pyrene	4.00	3.60	1.00	0.91	1.3	0.05
Total PAH (ppm)	33.96	25.02	10.11	9.78	11.14	7.76
Total TOC (ppm)	4,080	5,060	7,430	6,150	1,320	1,770

PAH		
min	max	average
7.76	33.96	16.29

TOC		
min	max	average
1,320	7,430	4,302

Table 11. State of Ohio criteria for beneficial use of dredged material (from GLC, 2004).

Contaminant	Cover for Residential Use	Cover for Industrial Use	Fill, Unrestrictive
Arsenic	12[a]	41	12
Lead	140	300	70
Zinc	200	2800	200
PCBs	1.3	--	0.5
Benzo(a)pyrene	0.7	--	0.1
Benzene	0.5	--	0.05
Criteria Source	CEQG[b]	Sludge Rules[c]	CEQG[d]

a: All values are in mg kg^{-1} and applicable for the use classification.
b: Adapted from Canadian Environmental Quality Guidelines for residential soil.
c: Based on monthly average limits contained in Ohio's sewage sludge rules.
d: Adapted from Canadian Environmental Quality Guidelines for soil based on the most stringent value.

Table 12. Physical soil characteristics.

Lorain Soil Data						
Sample	Field Moisture %	pH	Particle Size Analysis (%)			TOC mg/kg
			Sand	Silt	Clay	
Lorain CDF	32.2	7.2	25.0	53.3	21.7	12,000
Reference	22.3	6.9	31.7	52.5	15.8	31,000

Table 13. Soil composite metals, mg kg^{-1}.

Metals	CDF	Reference	Criteria
As	12	14	12 – 41*
Cd	5.4	3.8	10 - 22**
Cr	33	21	218**
Cu	47	27	1127**
Hg	0.095	0.047	6.6 – 50**
Ni	37	26	50**
Pb	39	28	70 – 300*
Ag	0.3	<1	--
Zn	189	140	200 – 2800*

* State of Ohio criteria for unrestricted fill (most restrictive) to cover for industrial use.
** From Canadian Environmental Quality Guidelines (2006) for residential/park – industrial.
a: State of Ohio criteria for PCBs is 0.5 mg kg^{-1} for unrestricted fill, 1.3 mg kg^{-1} for residential cover (GLC, 2004). CEQG criteria for DDT is 0.7 mg kg^{-1} for residential/park and 12.0 mg kg^{-1} for industrial.

Table 14. Soil composite PAH concentrations, mg kg^{-1}.

Analyte	CDF	Reference	Criteria[3]
Naphthalene	0.130 J[1]	0.180 J	0.1 - 22
2-Methylnaphthalene	0.070 J	0.230 J	
Acenaphthylene	0.030 J	<0.250	
Acenaphthene	0.040 J	<0.250	
Fluorene	0.040 J	<0.250	
Phenanthrene	0.390	0.200 J	
Anthracene	0.080 J	0.030 J	
Fluoranthene	0.620	0.150 J	
Pyrene	0.690	0.190 J	
Benzo (a) anthracene	0.310	0.100 J	
Chrysene	0.480	0.190 J	
Benzo (b) fluoranthene	0.890 I[2]	0.270 I	
Benzo (k) fluoranthene	I	I	
Benzo (a) pyrene	0.410	0.130 J	0.1 - 0.7
Indeno (1,2,3-cd) pyrene	0.280	0.070 J	
Dibenz (a,H) anthracene	0.050 J	<0.250	
Benzo (g,h,i) perylene	0.250	0.070 J	

[1]Estimated concentration below the laboratory reporting limit (0.280 mg kg^{-1})
[2]Analytes reported as an isomeric pair due to insufficient resolution
[3] From Canadian Environmental Quality Guidelines (2006) for residential/park – industrial

Table 15. Plant biomass properties after 45 days of growth.

		Fresh wt. (g)	Dry wt (g)	% moisture
Lorain CDF	**mean**	**143.4**	**29.8**	**79.2**
	max	161.3	34.9	80.5
	min	126.7	27.1	78.4
Reference	**mean**	**102.8**	**23.1**	**77.7**
	max	118.9	28.1	79.1
	min	70.0	14.6	75.5

Table 16. Plant tissue concentrations of metals, mg kg^{-1} dry weight.

	Rep	As	Cd	Cr	Cu	Pb	Hg	Ni	Ag	Zn
Lorain CDF	1	<0.5	8.48	<0.5	9.67	3.87	0.0068	1.46	<0.5	77.65
Lorain CDF	2	0.63	6.64	1.47	11.51	25.3	0.0126	2.41	<0.5	77.7
Lorain CDF	3	<0.5	5.27	<0.5	8.99	2.68	0.005	0.75	<0.5	63.14
	Mean	**0.543**	**6.797**	**0.823**	**10.057**	**10.617**	**0.008**	**1.540**	**<0.50**	**72.830**
Reference	1	<0.5	4.57	<0.5	11.4	2.1	0.006	0.87	<0.5	81.62
Reference	2	<0.5	4.41	<0.5	10.69	4.96	0.0042	1.01	<0.5	104.34
Reference	3	<0.5	5.63	<0.5	9.11	4.73	0.0047	1.16	<0.5	92.03
	Mean	**<0.50**	**4.870**	**<0.50**	**10.400**	**3.930**	**0.005**	**1.013**	**<0.50**	**92.663**

Table 17. Eco-SSLs for soil contaminant concentrations[1].

CONTAMINANT	PLANT TO AVIAN PATHWAY	PLANT TO MAMMALIAN PATHWAY
Arsenic	67	170
Cadmium	28	73
Chromium[2]	78	380
Copper	76	1100
Lead	46	1200

[1] From USEPA (http://www.epa.gov/ecotox/ecossl/)
[2] Trivalent (Cr III)

Table 18. Toxicity Reference Values and used in Eco-SSL determinations[1].

CONTAMINANT	FOOD INGESTION RATE (KG DW/KG BW/D)	TOXICITY REFERENCE VALUE (MG DW/KG BW/D)	ACCEPTABLE PLANT CONC. MG/KG
	Plant to Mammalian	Plant to Mammalian	Mammalian
Arsenic	0.0875	1.04	11.818
Cadmium	0.0875	0.770	8.8
Chromium[2]	0.0875	2.40	27.273
Copper	0.0875	5.82	66.136
Lead	0.0875	4.70	53.409

[1] From USEPA (http://www.epa.gov/ecotox/ecossl/)
[2] Trivalent (CR III)

Table 19. Earthworm survival and growth.

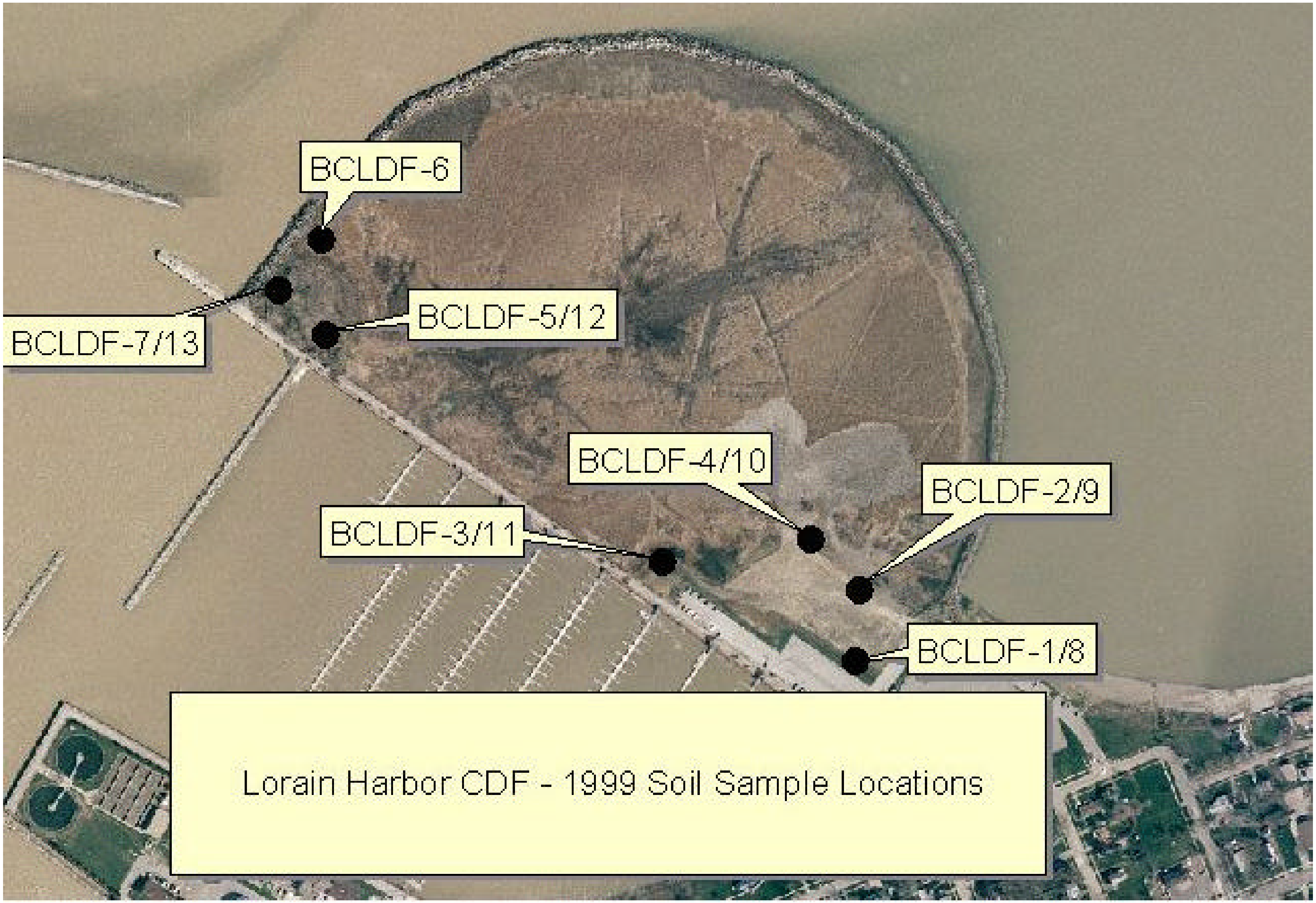
		Day 0 Count	Day 0 wt. (g)	Day 28 Count	Day 28 wt. (g)
Lorain CDF	**mean**	**75**	**24.3**	**69.2**	**15.8**
	max		25.5	75	17.8
	min		23.2	53	11.6
Reference	**mean**	**75**	**23.8**	**72.6**	**16.4**
	max		26.0	75	17.7
	min		21.5	67	15.0
Control	**mean**	**75**	**24.5**	**65.6**	**15.4**
	max		26.3	74	20.8
	min		22.2	49	12.2

Table 20. Uptake of PAH by earthworms, mg kg^{-1}.

	Replicate	Lorain CDF	Reference
PAH LRL	1	0.032	0.033
	2	0.030	0.031
	3	0.031	0.032
PAH MDL	1	0.013	0.013
	2	0.012	0.013
	3	0.012	0.013
	3	0.870	0.930
Chrysene	1	0.023 J[1]	Not detected
	2	0.019 J	Not detected
	3	0.018 J	Not detected
Benzo[b]- and Benzo[k]fluoranthene	1	0.033 I[2]	Not detected
	2	0.024 J I	Not detected
	3	0.024 J I	Not detected

[1]estimated concentration above the MDL but below the LRL
[2]analytes reported as an isomeric pair due to insufficient baseline resolution

APPENDIX A Summary tables of sampling results, from USACE 1999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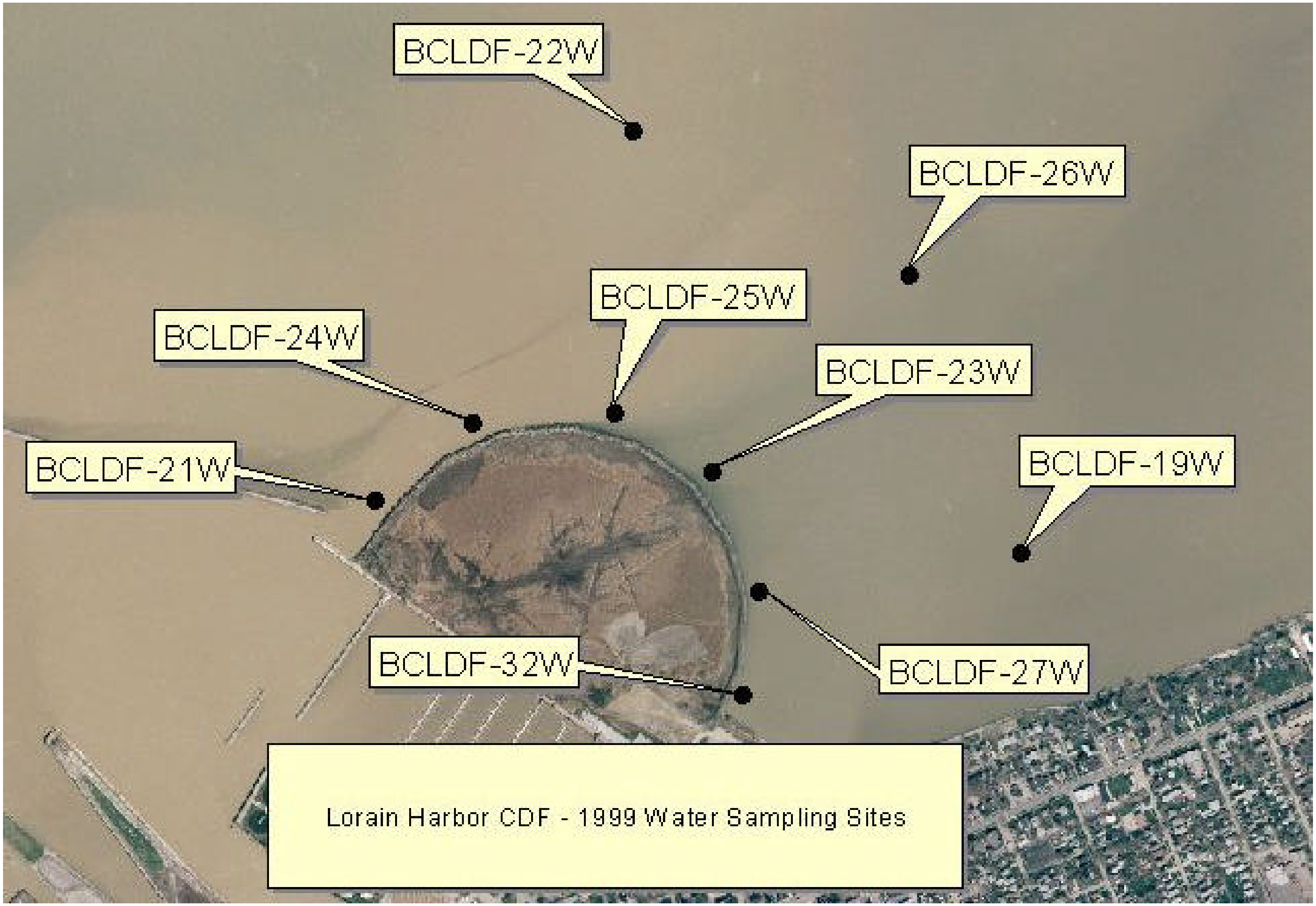
BCLDF-7/13
BCLDF-5/12
BCLDF-4/10
BCLDF-2/9
BCLDF-3/11
BCLDF-1/8
Lorain Harbor CDF - 1999 Soil Sample Locations


BCLDF-22W
BCLDF-26W
BCLDF-25W
BCLDF-24W
BCLDF-23W
BCLDF-21W
BCLDF-19W
BCLDF-32W
BCLDF-27W
Lorain Harbor CDF - 1999 Water Sampling Sites

LORAIN CDF 1999 VOLATILE SOILS DATA

Volatiles	BCLDF 8 Soil Oxidized ug/kg	BCLDF 8 Leachate Oxidized ug/l	BCLDF 1 Soil Reduced ug/kg	BCLDF 1 Leachate Reduced ug/l	BCLDF 9 Soil Oxidized ug/kg	BCLDF 9 Leachate Oxidized ug/l	BCLDF 2 Soil Reduced ug/kg	BCLDF 2 Leachate Reduced ug/l
1,1,1,2-Tetrachloroethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,1,1-Trichloroethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,1,2,2-Tetrachloroethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,1,2-Trichloroethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,1-Dichloroethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,1-Dichloroethene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,1-Dichloropropene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,2,3-Trichlorobenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,2,3-Trichloropropane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,2,4-Trichlorobenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,2,4-Trimethylbenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,2-Dibromo-3-chloropropane	<11	<1.0	<15	<1.0	<11	<1.0	<13	<1.0
1,2-Dibromoethane (EDB)	<11	<0.5	<15	<0.5	<11	<0.5	<13	<0.5
1,2-Dichlorobenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,2-Dichloroethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,2-Dichloropropane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,3,5-Trimethylbenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1.3-Dichlorobenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,3-Dichloropropane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,3-Dichloropropene (cis&trans)	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
1,4-Dichlorobenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
2,2-Dichloropropane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
2-Chlorotoluene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
2-Hexanone	<110	<5.0	<150	<5.0	<110	<5.0	<130	<5.0
4-Chlorotoluene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
4-Methyl-2-Pentanone (MIBK)	<110	<5	<150	<5	<110	<5	<130	<5
Acetone	<110	<20	<150	<20	<110	<20	<130	<20
Benzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Bromobenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Bromochloromethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Bromodichloromethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Bromoform	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Bromomethane	<11	<0.5	<15	<0.5	<11	<0.5	<13	<0.5
Carbon Disulfide	<5	<5.0	<7	<5.0	<5	<5.0	<6	<5.0
Carbon tetrachloride	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Chlorobenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Chloroethane	<11	<0.5	<15	<0.5	<11	<0.5	<13	<0.5
Chloroform	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Chloromethane	<11	<0.5	<15	<0.5	<11	<0.5	<13	<0.5
cis-1,2-Dichloroethene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Dibromochloromethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Dibromomethane	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Dichlorodifluoromethane	28	<0.5	<15	<0.5	49	<0.5	<13	<0.5
Ethylbenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Hexachlorobutadiene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Isopropylbenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
m&p Xylenes	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Methyl ethyl ketone	<110	<5.0	<150	<5.0	<110	<5.0	<130	<5.0
Methylene chloride	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
n-Butylbenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
n-Propylbenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
o-Xylene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
p-Isopropyltoluene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
sec-Butylbenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Styrene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
tert-Butylbenzene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Tetrachloroethene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Toluene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
trans-1,2-Dichloroethene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Trichloroethene	<5	<0.5	<7	<0.5	<5	<0.5	<6	<0.5
Trichlorofluoromethane	<11	<0.5	<7	<0.5	<11	<0.5	<13	<0.5
Vinyl acetate	<110	<5.0	<150	<5.0	<110	<5.0	<130	<5.0
Vinyl chloride	<11	<0.5	<15	<0.5	<11	<0.5	<13	<0.5

LORAIN CDF 1999 VOLATILE SOILS DATA

Volatiles	BCLDF 11 Soil Oxidized ug/kg	BCLDF 11 Leachate Oxidized ug/l	BCLDF 3 Soil Reduced ug/kg	BCLDF 3 Leachate Reduced ug/l	BCLDF 10 Soil Oxidized ug/kg	BCLDF 10 Leachate Oxidized ug/l	BCLDF 4 Soil Reduced ug/kg	BCLDF 4 Leachate Reduced ug/l
1,1,1,2-Tetrachloroethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,1,1-Trichloroethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,1,2,2-Tetrachloroethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,1,2-Trichloroethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,1-Dichloroethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,1-Dichloroethene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,1-Dichloropropene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,2,3-Trichlorobenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,2,3-Trichloropropane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,2,4-Trichlorobenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,2,4-Trimethylbenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,2-Dibromo-3-chloropropane	<11	<1.0	<13	<1.0	<11	<1.0	<13	<1.0
1,2-Dibromoethane (EDB)	<11	<0.5	<13	<0.5	<11	<0.5	<13	<0.5
1,2-Dichlorobenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,2-Dichloroethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,2-Dichloropropane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,3,5-Trimethylbenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1.3-Dichlorobenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,3-Dichloropropane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,3-Dichloropropene (cis&trans)	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
1,4-Dichlorobenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
2,2-Dichloropropane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
2-Chlorotoluene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
2-Hexanone	<110	<5.0	<130	<5.0	<110	<5.0	<130	<5.0
4-Chlorotoluene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
4-Methyl-2-Pentanone (MIBK)	<110	<5	<130	<5	<110	<5	<130	<5
Acetone	<110	<20	<130	<20	<110	<20	<130	<20
Benzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Bromobenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Bromochloromethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Bromodichloromethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Bromoform	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Bromomethane	<11	<0.5	<13	<0.5	<11	<0.5	<13	<0.5
Carbon Disulfide	<5	<5.0	<6	<5.0	<5	<5.0	<6	<5.0
Carbon tetrachloride	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Chlorobenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Chloroethane	<11	<0.5	<13	<0.5	<11	<0.5	<13	<0.5
Chloroform	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Chloromethane	<11	<0.5	<13	<0.5	<11	<0.5	<13	<0.5
cis-1,2-Dichloroethene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Dibromochloromethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Dibromomethane	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Dichlorodifluoromethane	16	<0.5	37	<0.5	71	<0.5	17	<0.5
Ethylbenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Hexachlorobutadiene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Isopropylbenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
m&p Xylenes	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Methyl ethyl ketone	<110	<5.0	<130	<5.0	<110	<5.0	<130	<5.0
Methylene chloride	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
n-Butylbenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
n-Propylbenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
o-Xylene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
p-Isopropyltoluene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
sec-Butylbenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Styrene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
tert-Butylbenzene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Tetrachloroethene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Toluene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
trans-1,2-Dichloroethene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Trichloroethene	<5	<0.5	<6	<0.5	<5	<0.5	<6	<0.5
Trichlorofluoromethane	<11	<0.5	<13	<0.5	<11	<0.5	<13	<0.5
Vinyl acetate	<110	<5.0	<130	<5.0	<110	<5.0	<130	<5.0
Vinyl chloride	<11	<0.5	<13	<0.5	<11	<0.5	<13	<0.5

LORAIN CDF 1999 VOLATILE SOILS DATA

Volatiles	BCLDF 12 Soil Oxidized ug/kg	BCLDF 12 Leachate Oxidized ug/l	BCLDF 5 Soil Reduced ug/kg	BCDF 5 Leachate Reduced ug/l	BCLDF X Soil Oxidized ug/kg	BCLDF X Leachate Oxidized ug/l	BCLDF 6 Soil Reduced ug/kg	BCLDF 6 Leachate Reduced ug/l
1,1,1,2-Tetrachloroethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,1,1-Trichloroethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,1,2,2-Tetrachloroethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,1,2-Trichloroethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,1-Dichloroethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,1-Dichloroethene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,1-Dichloropropene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,2,3-Trichlorobenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,2,3-Trichloropropane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,2,4-Trichlorobenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,2,4-Trimethylbenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,2-Dibromo-3-chloropropane	<11	<1.0	<13	<1.0	---	---	<13	<1.0
1,2-Dibromoethane (EDB)	<11	<0.5	<13	<0.5	---	---	<13	<0.5
1,2-Dichlorobenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,2-Dichloroethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,2-Dichloropropane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,3,5-Trimethylbenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1.3-Dichlorobenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,3-Dichloropropane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,3-Dichloropropene (cis&trans)	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
1,4-Dichlorobenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
2,2-Dichloropropane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
2-Chlorotoluene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
2-Hexanone	<110	<5.0	<130	<5.0	---	---	<130	<5.0
4-Chlorotoluene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
4-Methyl-2-Pentanone (MIBK)	<110	<5	<130	<5	---	---	<130	<5
Acetone	<110	<20	<130	<20	---	---	<130	<20
Benzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Bromobenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Bromochloromethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Bromodichloromethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Bromoform	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Bromomethane	<11	<0.5	<13	<0.5	---	---	<13	<0.5
Carbon Disulfide	<5.5	<5.0	<6	<5.0	---	---	<6	<5.0
Carbon tetrachloride	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Chlorobenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Chloroethane	<11	<0.5	<13	<0.5	---	---	<13	<0.5
Chloroform	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Chloromethane	<11	<0.5	<13	<0.5	---	---	<13	<0.5
cis-1,2-Dichloroethene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Dibromochloromethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Dibromomethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Dichlorodifluoromethane	38	<0.5	<13	<0.5	---	---	<13	<0.5
Ethylbenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Hexachlorobutadiene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Isopropylbenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
m&p Xylenes	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Methyl ethyl ketone	<110	<5.0	<130	<5.0	---	---	<130	<5.0
Methylene chloride	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
n-Butylbenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
n-Propylbenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
o-Xylene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
p-Isopropyltoluene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
sec-Butylbenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Styrene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
tert-Butylbenzene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Tetrachloroethene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Toluene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
trans-1,2-Dichloroethene	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Trichloroethane	<5.5	<0.5	<6	<0.5	---	---	<6	<0.5
Trichlorofluoromethane	<11	<0.5	<13	<0.5	---	---	<13	<0.5
Vinyl acetate	<110	<5.0	<130	<5.0	---	---	<130	<5.0
Vinyl chloride	<11	<0.5	<13	<0.5	---	---	<13	<0.5

LORAIN CDF 1999 VOLATILE SOILS DATA

Volatiles	BCLDF 13 Soil Oxidized ug/kg	BCLDF 13 Leachate Oxidized ug/l	BCLDF 7 Soil Reduced ug/kg	BCLDF 7 Leachate Reduced ug/l
1,1,1,2-Tetrachloroethane	<5	<0.5	<6	<0.5
1,1,1-Trichloroethane	<5	<0.5	<6	<0.5
1,1,2,2-Tetrachloroethane	<5	<0.5	<6	<0.5
1,1,2-Trichloroethane	<5	<0.5	<6	<0.5
1,1-Dichloroethane	<5	<0.5	<6	<0.5
1,1-Dichloroethene	<5	<0.5	<6	<0.5
1,1-Dichloropropene	<5	<0.5	<6	<0.5
1,2,3-Trichlorobenzene	<5	<0.5	<6	<0.5
1,2,3-Trichloropropane	<5	<0.5	<6	<0.5
1,2,4-Trichlorobenzene	<5	<0.5	<6	<0.5
1,2,4-Trimethylbenzene	<5	<0.5	<6	<0.5
1,2-Dibromo-3-chloropropane	<10	<1.0	<13	<1.0
1,2-Dibromoethane (EDB)	<10	<0.5	<13	<0.5
1,2-Dichlorobenzene	<5	<0.5	<6	<0.5
1,2-Dichloroethane	<5	<0.5	<6	<0.5
1,2-Dichloropropane	<5	<0.5	<6	<0.5
1,3,5-Trimethylbenzene	<5	<0.5	<6	<0.5
1.3-Dichlorobenzene	<5	<0.5	<6	<0.5
1,3-Dichloropropane	<5	<0.5	<6	<0.5
1,3-Dichloropropene (cis&trans)	<5	<0.5	<6	<0.5
1,4-Dichlorobenzene	<5	<0.5	<6	<0.5
2,2-Dichloropropane	<5	<0.5	<6	<0.5
2-Chlorotoluene	<5	<0.5	<6	<0.5
2-Hexanone	<100	<5.0	<130	<5.0
4-Chlorotoluene	<5	<0.5	<6	<0.5
4-Methyl-2-Pentanone (MIBK)	<100	<5	<130	<5
Acetone	<100	<20	<130	<20
Benzene	<5	<0.5	<6	<0.5
Bromobenzene	<5	<0.5	<6	<0.5
Bromochloromethane	<5	<0.5	<6	<0.5
Bromodichloromethane	<5	<0.5	<6	<0.5
Bromoform	<5	<0.5	<6	<0.5
Bromomethane	<10	<0.5	<13	<0.5
Carbon Disulfide	<5	<5.0	<6	<5.0
Carbon tetrachloride	<5	<0.5	<6	<0.5
Chlorobenzene	<5	<0.5	<6	<0.5
Chloroethane	<10	<0.5	<13	<0.5
Chloroform	<5	<0.5	<6	<0.5
Chloromethane	<10	<0.5	<13	<0.5
cis-1,2-Dichloroethene	<5	<0.5	<6	<0.5
Dibromochloromethane	<5	<0.5	<6	<0.5
Dibromomethane	<5	<0.5	<6	<0.5
Dichlorodifluoromethane	39	<0.5	<13	<0.5
Ethylbenzene	<5	<0.5	<6	<0.5
Hexachlorobutadiene	<5	<0.5	<6	<0.5
Isopropylbenzene	<5	<0.5	<6	<0.5
m&p Xylenes	<5	<0.5	<6	<0.5
Methyl ethyl ketone	<100	<5.0	<130	<5.0
Methylene chloride	<5	<0.5	<6	<0.5
n-Butylbenzene	<5	<0.5	<6	<0.5
n-Propylbenzene	<5	<0.5	<6	<0.5
o-Xylene	<5	<0.5	<6	<0.5
p-Isopropyltoluene	<5	<0.5	<6	<0.5
sec-Butylbenzene	<5	<0.5	<6	<0.5
Styrene	<5	<0.5	<6	<0.5
tert-Butylbenzene	<5	<0.5	<6	<0.5
Tetrachloroethene	<5	<0.5	<6	<0.5
Toluene	<5	<0.5	<6	<0.5
trans-1,2-Dichloroethene	<5	<0.5	<6	<0.5
Trichloroethane	<5	<0.5	<6	<0.5
Trichlorofluoromethane	<10	<0.5	<13	<0.5
Vinyl acetate	<100	<5.0	<130	<5.0
Vinyl chloride	<10	<0.5	<13	<0.5

LORAIN CDF 19997 VOLATILES OUTSIDE DIKE WATER

Volatiles	BCLDF 20W Water ug/l	BCLDF 21W Water ug/l	BCLDF 23W Water ug/l	BCLDF 24W Water ug/l	BCLDF 25W Water ug/l	BCLDF 27W Water ug/l	BCLDF 32W Water ug/l
1,1,1,2-Tetrachloroethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,1-Trichloroethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2,2-Tetrachloroethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloropropene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,3-Trichlorobenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,3-Trichloropropane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,4-Trichlorobenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,4-Trimethylbenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dibromo-3-chloropropane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dibromoethane (EDB)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichlorobenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichloroethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichloropropane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3,5-Trimethylbenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1.3-Dichlorobenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-Dichloropropane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-Dichloropropene (cis&trans)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,4-Dichlorobenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,2-Dichloropropane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorotoluene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Hexanone	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
4-Chlorotoluene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Methyl-2-Pentanone (MIBK)	<5	<5	<5	<5	<5	<5	<5
Acetone	<20	<20	<20	<20	<20	<20	<20
Benzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromobenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromochloromethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromodichloromethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromomethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbon Disulfide	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbon tetrachloride	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorobenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroform	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloromethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
cis-1,2-Dichloroethene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromochloromethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromomethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dichlorodifluoromethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobutadiene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Isopropylbenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m&p Xylenes	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Methyl ethyl ketone	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Methylene chloride	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-Butylbenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-Propylbenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
p-Isopropyltoluene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
sec-Butylbenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Styrene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
tert-Butylbenzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tetrachloroethene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trans-1,2-Dichloroethene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloroethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichlorofluoromethane	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Vinyl acetate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Vinyl chloride	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

LORAIN CDF 1999 VOLATILE BACKGROUND LAKE WATER DATA

Volatiles	BCLDF 19W Water ug/l	BCLDF 22W Water ug/l	BCLDF 26W Water ug/l
1,1,1,2-Tetrachloroethane	<0.5	<0.5	<0.5
1,1,1-Trichloroethane	<0.5	<0.5	<0.5
1,1,2,2-Tetrachloroethane	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	<0.5	<0.5	<0.5
1,1-Dichloroethane	<0.5	<0.5	<0.5
1,1-Dichloroethene	<0.5	<0.5	<0.5
1,1-Dichloropropene	<0.5	<0.5	<0.5
1,2,3-Trichlorobenzene	<0.5	<0.5	<0.5
1,2,3-Trichloropropane	<0.5	<0.5	<0.5
1,2,4-Trichlorobenzene	<0.5	<0.5	<0.5
1,2,4-Trimethylbenzene	<0.5	<0.5	<0.5
1,2-Dibromo-3-chloropropane	<1.0	<1.0	<1.0
1,2-Dibromoethane (EDB)	<0.5	<0.5	<0.5
1,2-Dichlorobenzene	<0.5	<0.5	<0.5
1,2-Dichloroethane	<0.5	<0.5	<0.5
1,2-Dichloropropane	<0.5	<0.5	<0.5
1,3,5-Trimethylbenzene	<0.5	<0.5	<0.5
1.3-Dichlorobenzene	<0.5	<0.5	<0.5
1,3-Dichloropropane	<0.5	<0.5	<0.5
1,3-Dichloropropene (cis&trans)	<0.5	<0.5	<0.5
1,4-Dichlorobenzene	<0.5	<0.5	<0.5
2,2-Dichloropropane	<0.5	<0.5	<0.5
2-Chlorotoluene	<0.5	<0.5	<0.5
2-Hexanone	<5.0	<5.0	<5.0
4-Chlorotoluene	<0.5	<0.5	<0.5
4-Methyl-2-Pentanone (MIBK)	<5	<5	<5
Acetone	<20	<20	<20
Benzene	<0.5	<0.5	<0.5
Bromobenzene	<0.5	<0.5	<0.5
Bromochloromethane	<0.5	<0.5	<0.5
Bromodichloromethane	<0.5	<0.5	<0.5
Bromoform	<0.5	<0.5	<0.5
Bromomethane	<0.5	<0.5	<0.5
Carbon Disulfide	<5.0	<5.0	<5.0
Carbon tetrachloride	<0.5	<0.5	<0.5
Chlorobenzene	<0.5	<0.5	<0.5
Chloroethane	<0.5	<0.5	<0.5
Chloroform	<0.5	<0.5	<0.5
Chloromethane	<0.5	<0.5	<0.5
cis-1,2-Dichloroethene	<0.5	<0.5	<0.5
Dibromochloromethane	<0.5	<0.5	<0.5
Dibromomethane	<0.5	<0.5	<0.5
Dichlorodifluoromethane	<0.5	<0.5	<0.5
Ethylbenzene	<0.5	<0.5	<0.5
Hexachlorobutadiene	<0.5	<0.5	<0.5
Isopropylbenzene	<0.5	<0.5	<0.5
m&p Xylenes	<0.5	<0.5	<0.5
Methyl ethyl ketone	<5.0	<5.0	<5.0
Methylene chloride	<0.5	<0.5	<0.5
n-Butylbenzene	<0.5	<0.5	<0.5
n-Propylbenzene	<0.5	<0.5	<0.5
o-Xylene	<0.5	<0.5	<0.5
p-Isopropyltoluene	<0.5	<0.5	<0.5
sec-Butylbenzene	<0.5	<0.5	<0.5
Styrene	<0.5	<0.5	<0.5
tert-Butylbenzene	<0.5	<0.5	<0.5
Tetrachloroethene	<0.5	<0.5	<0.5
Toluene	<0.5	<0.5	<0.5
trans-1,2-Dichloroethene	<0.5	<0.5	<0.5
Trichloroethane	<0.5	<0.5	<0.5
Trichlorofluoromethane	<0.5	<0.5	<0.5
Vinyl acetate	<5.0	<5.0	<5.0
Vinyl chloride	<0.5	<0.5	<0.5

LORAIN CDF 1999 METALS SOILS DATA

Metals	BCLDF 8 Soil Oxidized mg/kg	BCLDF 8 Leachate Oxidized ug/l	BCLDF 1 Soil Reduced mg/kg	BCLDF 1 Leachate Reduced ug/l	BCLDF 9 Soil Oxidized mg/kg	BCLDF 9 Leachate Oxidized ug/l	BCLDF 2 Soil Reduced mg/kg	BCLDF 2 Leachate Reduced ug/l
Aluminum	3480	390	4330	680	3400	550	6980	640
Antimony	<0.7	<2.2	0.5	7	<0.7	<2.2	<1.5	2.6
Arsenic	5	2.1	7	6.1	5	1.8	10	3.1
Barium	32	36	47	218	45	44	77	53
Beryllium	0.1	<1	0.4	<1	0.3	<1	0.5	<1
Cadmium	8.31	0.2	8.4	0.59	7.8	0.33	16.5	0.93
Calcium	12600	14000	11900	17000	8140	24000	11000	68000
Chromium	24	5	28	<4	21	4	55	<4
Cobalt	9	<5	9	<5	8	5	11	<5
Copper	33	7	46	5	33	74	63	<3
Iron	36700	713	30100	1240	26900	1079	28400	1190
Lead	21	1.7	37	4.4	25	5.4	56	5.2
Magnesium	2800	2640	3430	3040	1930	3940	3800	11000
Manganese	693	24	461	31	460	31	450	146
Mercury	0.05	<0.3	0.12	<0.3	<0.08	<0.3	0.13	<0.3
Nickel	23	<6	29	<6	26	<6	39	<6
Potassium	561	1100	559	2200	600	1800	939	1500
Selenium	<0.4	<1.6	<0.4	<1.6	<0.5	<1.6	<0.6	<1.6
Silver	<0.3	<5	0.3	<5	<0.3	<5	5.7	<5
Sodium	<269	<4200	<196	5500	<256	<4200	<550	4900
Thallium	0.5	<0.3	0.7	<0.3	0.5	<0.3	0.7	<0.3
Vanadium	15	4	15	<3	18	3	24	<3
Zinc	100	18	141	57	116	20	234	33
TOC - mg/kg	2270	---	4080	---	2980	---	5060	---

Metals	BCLDF 11 Soil Oxidized mg/kg	BCLDF 11 Leachate Oxidized ug/l	BCLDF 3 Soil Reduced mg/kg	BCLDF 3 Leachate Reduced ug/l	BCLDF 10 Soil Oxidized mg/kg	BCLDF 10 Leachate Oxidized ug/l	BCLDF 4 Soil Reduced mg/kg	BCLDF 4 Leachate Reduced ug/l
Aluminum	5200	330	4940	3030	3100	260	4860	80
Antimony	<0.9	<2.2	<0.9	2.7	<0.8	2.4	<1.0	5.4
Arsenic	8	<1.2	7	6.1	5	<1.1	6	3.5
Barium	60	48	57	73	34	36	55	58
Beryllium	0.8	<1	0.2	<1	0.3	<1	0.2	<1
Cadmium	10.9	0.11	7.4	1.52	6.5	0.07	10.2	<0.03
Calcium	10400	70000	10500	29000	6920	29000	8330	17
Chromium	28	<4	23	13	20	5	37	<4
Cobalt	10	<5	10	<5	7	<5	11	<5
Copper	40	<3	40	17	27	<3	43	<3
Iron	25800	281	26700	5750	22000	165	27600	25
Lead	45	<1.1	50	20.5	24	<1.1	42	<1.1
Magnesium	3500	11000	3650	4500	2050	3800	2830	2870
Manganese	593	5	479	151	457	4	408	11
Mercury	0.13	<0.3	0.12	<0.3	0.05	<0.3	0.08	<0.3
Nickel	28	<10	31	<6	22	<6	37	<6
Potassium	759	1500	707	3700	559	1500	722	1900
Selenium	<0.6	<1.6	<0.6	<1.6	<0.6	<1.6	<0.8	1.7
Silver	<0.4	<5	0.5	<5	<0.4	<5	<0.5	<5
Sodium	<355	<4150	<334	<4.2	317	<4150	<384	<4.2
Thallium	0.6	<0.3	0.7	<0.3	0.4	<0.3	0.6	<0.3
Vanadium	19	3	16	13	14	<3	19	3
Zinc	144	26	127	90	98	21	169	38
TOC - mg/kg	5950	---	7430	---	4120	---	6150	---

LORAIN CDF 1999 METALS SOILS DATA

Metals	BCLDF 12 Soil Oxidized mg/kg	BCLDF 12 Leachate Oxidized ug/l	BCLDF 5 Soil Reduced mg/kg	BCDF 5 Leachate Reduced ug/l	BCLDF X Soil Oxidized mg/kg	BCLDF X Leachate Oxidized ug/l	BCLDF 6 Soil Reduced mg/kg	BCLDF 6 Leachate Reduced ug/l
Aluminum	2380	240	2430	140	---	---	2270	50
Antimony	<0.7	<2.2	<0.8	<2.2	---	---	<0.7	<2.2
Arsenic	8	1.8	8	<1.2	---	---	9	2.1
Barium	14	32	13	50	---	---	15	31
Beryllium	0.2	<1	0.3	<1	---	---	0.2	<1
Cadmium	2.2	0.04	1.8	0.06	---	---	214	0.03
Calcium	24800	20000	24200	120000	---	---	24600	17000
Chromium	4	<4	4	4	---	---	4	5
Cobalt	5	<5	7	<5	---	---	5	5
Copper	11	<3	11	5	---	---	12	<3
Iron	10200	552	10500	140	---	---	9870	221
Lead	9	<1.1	9	<1.1	---	---	9	<1.1
Magnesium	5490	1740	5080	4310	---	---	5490	800
Manganese	299	11	269	5	---	---	243	7
Mercury	0.02	<0.3	0.01	<0.3	---	---	0.04	<0.3
Nickel	11	<6	12	<6	---	---	10	1.1
Potassium	465	800	492	1200	---	---	452	1100
Selenium	<0.5	<1.6	<0.6	<1.6	---	---	<0.5	<1.6
Silver	<0.3	<5	<0.4	19	---	---	<0.3	<5
Sodium	<253	<4150	303	<4200	---	---	<263	<4200
Thallium	0.2	<0.3	0.3	<0.3	---	---	0.2	<0.3
Vanadium	7	<3	7	3	---	---	7	5
Zinc	67	11	54	24	---	---	63	10

TOC - mg/kg	1310	---	1320	---	---	---	1770	---

Metals	BCLDF 13 Soil Oxidized mg/kg	BCLDF 13 Leachate Oxidized ug/l	BCLDF 7 Soil Reduced mg/kg	BCLDF 7 Leachate Reduced ug/l
Aluminum	2190	290	3070	110
Antimony	<0.8	<2.2	<0.7	<2.2
Arsenic	7	3.6	7	43
Barium	12	54	26	88
Beryllium	0.3	<1	<0.1	<1
Cadmium	2.2	0.06	2.99	0.07
Calcium	26100	36000	23500	250000
Chromium	5	<4	9	<4
Cobalt	5	<5	7	<5
Copper	14	<3	18	<3
Iron	10900	759	14200	93
Lead	9	<1.1	12	<1.1
Magnesium	6020	3030	5360	17000
Manganese	323	15	296	3
Mercury	0.01	<0.3	0.04	<0.3
Nickel	11	<6	17	<6
Potassium	385	<400	480	1000
Selenium	<0.6	<1.6	<0.06	<1.6
Silver	<0.4	<5	0.4	<5
Sodium	<298	<4200	<254	5800
Thallium	0.2	<0.3	0.4	<0.3
Vanadium	7	<3	10	<3
Zinc	73	14	76	26

TOC - mg/kg	871	---	4060	---

LORAIN CDF 1999 METALS OUTSIDE DIKE WATER DATA

Metals	BCLDF 20W Water ug/l	BCLDF 21W Water ug/l	BCLDF 23W Water ug/l	BCLDF 24W Water ug/l	BCLDF 25W Water ug/l	BCLDF 27W Water ug/l	BCLDF 32W Water ug/l
Aluminum	287	290	204	135	200	500	339
Antimony	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
Arsenic	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Barium	20	21	7	19	20	22	19
Beryllium	<1	<1	<1	<1	<1	<1	<1
Cadmium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Calcium	31000	30000	28000	26000	28000	29000	29000
Chromium	<4	<4	<4	<4	<4	<4	<4
Cobalt	<5	<5	<5	<5	<5	<5	<5
Copper	<3	8	8	8	11	8	<3
Iron	399	447	341	197	241	808	410
Lead	2.9	3.1	3	3.2	2.8	3.2	3.1
Magnesium	8200	8	7600	7100	7500	7700	7700
Manganese	11	21	7	4	6	22	10
Mercury	0.1	1.9	0.7	0.4	0.7	0.3	0.1
Nickel	7	8	<6	14	11	10	13
Potassium	2200	1800	900	1400	1500	1600	1100
Selenium	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Silver	<5	<5	<5	<5	<5	<5	<5
Sodium	9100	11500	8600	8300	8700	9300	8500
Thallium	<0.3	0.4	<0.3	0.5	0.7	0.5	0.6
Vanadium	<3	<3	<3	<3	<3	<3	<3
Zinc	5	11	6	<4	7	6	11

LORAIN CDF 1999 METALS BACKGROUND LAKE WATER DATA

Metals	BCLDF 19W Water ug/l	BCLDF 22W Water ug/l	BCLDF 26W Water ug/l
Aluminum	214	206	153
Antimony	<2.2	<2.2	<2.2
Arsenic	<1.2	<1.2	<1.2
Barium	19	18	18
Beryllium	<1	<1	<1
Cadmium	<0.5	<0.5	<0.5
Calcium	28000	27000	27000
Chromium	<4	<4	<4
Cobalt	<5	<5	<5
Copper	<3	11	7
Iron	265	283	208
Lead	2.3	2.5	3.0
Magnesium	7400	7300	7200
Manganese	7	4	4
Mercury	0.2	0.3	0.2
Nickel	<6	10	7
Potassium	1200	1200	1200
Selenium	<1.6	<1.6	<1.6
Silver	<5	11	<5
Sodium	8300	8100	8400
Thallium	0.4	<0.3	<0.3
Vanadium	<3	<3	<3
Zinc	5	5	<4

LORAIN CDF 1999 PAH SOILS DATA

PAHs	BCLDF 8 Soil Oxidized ug/kg	BCLDF 8 Leachate Oxidized ug/l	BCLDF 1 Soil Reduced ug/kg	BCLDF 1 Leachate Reduced ug/l	BCLDF 9 Soil Oxidized ug/kg	BCLDF 9 Leachate Oxidized ug/l	BCLDF 2 Soil Reduced ug/kg	BCLDF 2 Leachate Reduced ug/l
2-Methylnaphthalene	<580	<2	<770	<2	3100	<2	<660	<2
Acenaphthene	820	<2	940	<2	20000	<2	<660	<2
Acenaphthylene	<580	<2	760	<2	9600	<2	<660	<2
Anthracene	1600	<2	1500	<2	33000	<2	1000	<2
Benzo(a)Anthracene	1900	<3	2400	<3	59000	<3	2300	<3
Benzo(a)Pyrene	1200	<4	2500	<4	27000	<4	1500	<4
Benzo(b)Fluoranthene	1500	<4	2100	<4	40000	<4	1900	<4
Benzo(ghi)Perylene	<1400	<5	2400	<5	15000	<5	<1600	<5
Benzo(k)Fluoranthene	<1100	<4	2000	<4	5700	<4	<1330	<4
Chrysene	1900	<3	2100	<3	33000	<3	2100	<3
Dibenzo(a,h)Anthracene	<1400	<5	510	<5	4800	<5	<660	<5
Dibenzofuran	600	<2	<770	<2	12000	<2	<660	<2
Fluoranthene	6100	<2	5800	<2	81000	<2	4900	<2
Fluorene	<880	<3	<1150	<3	23000	<3	<1000	<3
Indeno(1,2,3-cd)Pyrene	<1400	<5	2400	<5	21000	<5	<1600	<5
Naphthalene	850	<2	<770	<2	4500	<2	730	<2
Phenanthrene	6000	<2	3200	<2	79000	<2	2900	<2
Pyrene	4100	<3	4000	<3	66000	<3	3600	<3

PAHs	BCLDF 11 Soil Oxidized ug/kg	BCLDF 11 Leachate Oxidized ug/l	BCLDF 3 Soil Reduced ug/kg	BCLDF 3 Leachate Reduced ug/l	BCLDF 10 Soil Oxidized ug/kg	BCLDF 10 Leachate Oxidized ug/l	BCLDF 4 Soil Reduced ug/kg	BCLDF 4 Leachate Reduced ug/l
2-Methylnaphthalene	<580	<2	<660	<2	<580	<2	<660	<2
Acenaphthene	<580	<2	<660	<2	<580	<2	<660	<2
Acenaphthylene	<580	<2	<660	<2	<580	<2	<660	<2
Anthracene	3500	<2	<660	<2	520	<2	<660	<2
Benzo(a)Anthracene	2900	<3	<750	<3	880	<3	<750	<3
Benzo(a)Pyrene	1700	<4	<660	<4	510	<4	<660	<4
Benzo(b)Fluoranthene	2000	<4	<1330	<4	<1100	<4	<1330	<4
Benzo(ghi)Perylene	<1400	<5	<1600	<5	<1400	<5	<1600	<5
Benzo(k)Fluoranthene	<1100	<4	<1330	<4	<1100	<4	<1330	<4
Chrysene	2800	<3	<1000	<3	9100	<3	<1000	<3
Dibenzo(a,h)Anthracene	<580	<5	<660	<5	<580	<5	<660	<5
Dibenzofuran	<580	<2	<660	<2	<580	<2	<660	<2
Fluoranthene	7700	<2	1500	<2	3000	<2	1500	<2
Fluorene	880	<3	<1000	<3	<880	<3	<1000	<3
Indeno(1,2,3-cd)Pyrene	<1400	<5	<1600	<5	<1400	<5	<1600	<5
Naphthalene	<580	<2	<660	<2	<580	<2	<660	<2
Phenanthrene	6400	<2	990	<2	2100	<2	750	<2
Pyrene	5200	<3	1000	<3	1500	<3	910	<3

LORAIN CDF 1999 PAH SOILS DATA

PAHs	BCLDF 12 Soil Oxidized ug/kg	BCLDF 12 Leachate Oxidized ug/l	BCLDF 5 Soil Reduced ug/kg	BCLDF 5 Leachate Reduced ug/l	BCLDF X Soil Oxidized ug/kg	BCLDF X Leachate Oxidized ug/l	BCLDF 6 Soil Reduced ug/kg	BCLDF 6 Leachate Reduced ug/l
2-Methylnaphthalene	<550	<2	<660	<2	---	---	<660	<2
Acenaphthene	<550	<2	<660	<2	---	---	<660	<2
Acenaphthylene	<550	<2	<660	<2	---	---	<660	<2
Anthracene	<550	<2	<660	<2	---	---	<660	<2
Benzo(a)Anthracene	<830	<3	<750	<3	---	---	<750	<3
Benzo(a)Pyrene	<550	<4	<660	<4	---	---	<660	<4
Benzo(b)Fluoranthene	<1110	<4	<1330	<4	---	---	<1330	<4
Benzo(ghi)Perylene	<1300	<5	<1600	<5	---	---	<1600	<5
Benzo(k)Fluoranthene	<1100	<4	<1330	<4	---	---	<1330	<4
Chrysene	<830	<3	830	<3	---	---	<1000	<3
Dibenzo(a,h)Anthracene	<550	<5	<660	<5	---	---	<660	<5
Dibenzofuran	<550	<2	<660	<2	---	---	<660	<2
Fluoranthene	<550	<2	1900	<2	---	---	<660	<2
Fluorene	<830	<3	<1000	<3	---	---	<1000	<3
Indeno(1,2,3-cd)Pyrene	<1330	<5	<1600	<5	---	---	<1600	<5
Naphthalene	<550	<2	<660	<2	---	---	<660	<2
Phenanthrene	<550	<2	990	<2	---	---	<660	<2
Pyrene	<830	<3	1300	<3	---	---	<100	<3

PAHs	BCLDF 13 Soil Oxidized ug/kg	BCLDF 13 Leachate Oxidized ug/l	BCLDF 7 Soil Reduced ug/kg	BCLDF 7 Leachate Reduced ug/l
2-Methylnaphthalene	<500	<2	<660	<2
Acenaphthene	<500	<2	<660	<2
Acenaphthylene	<500	<2	<660	<2
Anthracene	<500	<2	<660	<2
Benzo(a)Anthracene	<750	<3	<750	<3
Benzo(a)Pyrene	<500	<4	<660	<4
Benzo(b)Fluoranthene	<100	<4	<1330	<4
Benzo(ghi)Perylene	<1200	<5	<1600	<5
Benzo(k)Fluoranthene	<1000	<4	<1330	<4
Chrysene	<750	<3	<1000	<3
Dibenzo(a,h)Anthracene	<500	<5	<660	<5
Dibenzofuran	<500	<2	<660	<2
Fluoranthene	<500	<2	760	<2
Fluorene	<750	<3	<1000	<3
Indeno(1,2,3-cd)Pyrene	<1200	<5	<1600	<5
Naphthalene	<500	<2	<660	<2
Phenanthrene	<500	<2	<660	<2
Pyrene	<750	<3	<100	<3

LORAIN CDF 1999 PAH OUTSIDE DIKE WATER DATA

PAHs	BCLDF 20W Water ug/l	BCLDF 21W Water ug/l	BCLDF 23W Water ug/l	BCLDF 24W Water ug/l	BCLDF 25W Water ug/l	BCLDF 27W Water ug/l	BCLDF 32W Water ug/l
2-Methylnaphthalene	<2	<2	<2	<2	<2	<2	<2
Acenaphthene	<2	<2	<2	<2	<2	<2	<2
Acenaphthylene	<2	<2	<2	<2	<2	<2	<2
Anthracene	<2	<2	<2	<2	<2	<2	<2
Benzo(a)Anthracene	<3	<3	<3	<3	<3	<3	<3
Benzo(a)Pyrene	<4	<4	<4	<4	<4	<4	<4
Benzo(b)Fluoranthene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	<5	<5	<5	<5	<5	<5	<5
Benzo(k)Fluoranthene	<4	<4	<4	<4	<4	<4	<4
Chrysene	<3	<3	<3	<3	<3	<3	<3
Dibenzo(a,h)Anthracene	<5	<5	<5	<5	<5	<5	<5
Dibenzofuran	<2	<2	<2	<2	<2	<2	<2
Fluoranthene	<2	<2	<2	<2	<2	<2	<2
Fluorene	<3	<3	<3	<3	<3	<3	<3
Indeno(1,2,3-cd)Pyrene	<5	<5	<5	<5	<5	<5	<5
Naphthalene	<2	<2	<2	<2	<2	<2	<2
Phenanthrene	<2	<2	<2	<2	<2	<2	<2
Pyrene	<3	<3	<3	<3	<3	<3	<3

LORAIN CDF 1999 PAH BACKGROUND LAKE WATER DATA

PAHs	BCLDF 19W Water ug/l	BCLDF 22W Water ug/l	BCLDF 26W Water ug/l
2-Methylnaphthalene	<2	<2	<2
Acenaphthene	<2	<2	<2
Acenaphthylene	<2	<2	<2
Anthracene	<2	<2	<2
Benzo(a)Anthracene	<3	<3	<3
Benzo(a)Pyrene	<4	<4	<4
Benzo(b)Fluoranthene	<4	<4	<4
Benzo(ghi)Perylene	<5	<5	<5
Benzo(k)Fluoranthene	<4	<4	<4
Chrysene	<3	<3	<3
Dibenzo(a,h)Anthracene	<5	<5	<5
Dibenzofuran	<2	<2	<2
Fluoranthene	<2	<2	<2
Fluorene	<3	<3	<3
Indeno(1,2,3-cd)Pyrene	<5	<5	<5
Naphthalene	<2	<2	<2
Phenanthrene	<2	<2	<2
Pyrene	<3	<3	<3

LORAIN CDF 1999 PCB SOILS DATA

PCBs	BCLDF 8 Soil Oxidized ug/kg	BCLDF 8 Leachate Oxidized ug/l	BCLDF 1 Soil Reduced ug/kg	BCLDF 1 Leachate Reduced ug/l	BCLDF 9 Soil Oxidized ug/kg	BCLDF 9 Leachate Oxidized ug/l	BCLDF 2 Soil Reduced ug/kg	BCLDF 2 Leachate Reduced ug/l
Aroclor 1016	<1100	<0.1	<150	<0.1	<1100	<0.1	<130	<0.1
Aroclor 1221	<1100	<0.1	<150	<0.1	<1100	<0.1	<130	<0.1
Aroclor 1232	<1100	<0.1	<150	<0.1	<1100	<0.1	<130	<0.1
Aroclor 1242	<1100	<0.1	<150	<0.1	<1100	<0.1	<130	<0.1
Aroclor 1248	<1100	<0.1	<150	<0.1	<1100	<0.1	<130	<0.1
Aroclor 1254	<1100	<0.1	660	<0.1	<1100	<0.1	360	<0.1
Aroclor 1260	<1100	<0.1	<150	<0.1	<1100	<0.1	<130	<0.1

PCBs	BCLDF 11 Soil Oxidized ug/kg	BCLDF 11 Leachate Oxidized ug/l	BCLDF 3 Soil Reduced ug/kg	BCLDF 3 Leachate Reduced ug/l	BCLDF 10 Soil Oxidized ug/kg	BCLDF 10 Leachate Oxidized ug/l	BCLDF 4 Soil Reduced ug/kg	BCLDF 4 Leachate Reduced ug/l
Aroclor 1016	<110	<0.1	<130	<0.1	<110	<0.1	<130	<0.1
Aroclor 1221	<110	<0.1	<130	<0.1	<110	<0.1	<130	<0.1
Aroclor 1232	<110	<0.1	<130	<0.1	<110	<0.1	<130	<0.1
Aroclor 1242	<110	<0.1	<130	<0.1	<110	<0.1	<130	<0.1
Aroclor 1248	<110	<0.1	<130	<0.1	<110	<0.1	<130	<0.1
Aroclor 1254	210	<0.1	<130	<0.1	<110	<0.1	310	<0.1
Aroclor 1260	<110	<0.1	<130	<0.1	<110	<0.1	<130	<0.1

LORAIN CDF 1999 PCB SOILS DATA

PCBs	BCLDF 12 Soil Oxidized ug/kg	BCLDF 12 Leachate Oxidized ug/l	BCLDF 5 Soil Reduced ug/kg	BCDF 5 Leachate Reduced ug/l	BCLDF X Soil Oxidized ug/kg	BCLDF X Leachate Oxidized ug/l	BCLDF 6 Soil Reduced ug/kg	BCLDF 6 Leachate Reduced ug/l
Aroclor 1016	<110	<0.1	<130	<0.1	---	---	<130	<0.1
Aroclor 1221	<110	<0.1	<130	<0.1	---	---	<130	<0.1
Aroclor 1232	<110	<0.1	<130	<0.1	---	---	<130	<0.1
Aroclor 1242	<110	<0.1	<130	<0.1	---	---	<130	<0.1
Aroclor 1248	<110	<0.1	<130	<0.1	---	---	<130	<0.1
Aroclor 1254	<110	<0.1	<130	<0.1	---	---	<130	<0.1
Aroclor 1260	<110	<0.1	<130	<0.1	---	---	<130	<0.1

PCBs	BCLDF 13 Soil Oxidized ug/kg	BCLDF 13 Leachate Oxidized ug/l	BCLDF 7 Soil Reduced ug/kg	BCLDF 7 Leachate Reduced ug/l
Aroclor 1016	<100	<0.1	<130	<0.1
Aroclor 1221	<100	<0.1	<130	<0.1
Aroclor 1232	<100	<0.1	<130	<0.1
Aroclor 1242	<100	<0.1	<130	<0.1
Aroclor 1248	<100	<0.1	<130	<0.1
Aroclor 1254	<100	<0.1	<130	<0.1
Aroclor 1260	<100	<0.1	<130	<0.1

LORAIN CDF 1999 PCB OUTSIDE DIKE WATER DATA

PCBs	BCLDF 20W Water ug/l	BCLDF 21W Water ug/l	BCLDF 23W Water ug/l	BCLDF 24W Water ug/l	BCLDF 25W Water ug/l	BCLDF 27W Water ug/l	BCLDF 32W Water ug/l
Aroclor 1016	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1221	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1232	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1242	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1248	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1254	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1260	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

LORAIN CDF 1999 PCB BACKGROUND LAKE WATER DATA

PCBs	BCLDF 19W Water ug/l	BCLDF 22W Water ug/l	BCLDF 26W Water ug/l
Aroclor 1016	<0.1	<0.1	<0.1
Aroclor 1221	<0.1	<0.1	<0.1
Aroclor 1232	<0.1	<0.1	<0.1
Aroclor 1242	<0.1	<0.1	<0.1
Aroclor 1248	<0.1	<0.1	<0.1
Aroclor 1254	<0.1	<0.1	<0.1
Aroclor 1260	<0.1	<0.1	<0.1

LORAIN CDF 1999 PESTICIDES SOIL DATA

Pesticides	BCLDF 8 Soil Oxidized ug/kg	BCLDF 8 Leachate Oxidized ug/l	BCLDF 1 Soil Reduced ug/kg	BCLDF 1 Leachate Reduced ug/l	BCLDF 9 Soil Oxidized ug/kg	BCLDF 9 Leachate Oxidized ug/l	BCLDF 2 Soil Reduced ug/kg	BCLDF 2 Leachate Reduced ug/l
4,4'-DDD	<230	<0.02	<30	<0.02	<220	<0.02	<30	<0.02
4,4'-DDE	<330	<0.03	<50	<0.03	<330	<0.03	<40	<0.03
4,4-DDT	<330	<0.03	<50	<0.03	<330	<0.03	<40	<0.03
Aldrin	<230	<0.02	<30	<0.02	<220	<0.02	<30	<0.02
alpha-BHC	<230	<0.02	<30	<0.02	<220	<0.02	<30	<0.02
beta-BHC	<230	<0.02	<30	<0.02	<220	<0.02	<30	<0.02
Chlordane	<1100	<0.10	<150	<0.10	<1100	<0.10	<130	<0.10
delta-BHC	<230	<0.02	<30	<0.02	<220	<0.02	<30	<0.02
Dieldrin	<230	<0.02	<30	<0.02	<220	<0.02	<30	<0.02
Endosulfan I	<330	<0.03	<50	<0.03	<330	<0.03	<40	<0.03
Endosulfan II	<330	<0.03	<50	<0.03	<330	<0.03	<40	<0.03
Endosulfan sulfate	<330	<0.03	<50	<0.03	<330	<0.03	<40	<0.03
Endrin	<550	<0.05	<77	<0.05	<550	<0.05	<66	<0.05
Endrin aldehyde	<550	<0.05	<77	<0.05	<550	<0.05	<66	<0.05
gamma-BHC (Lindane)	<230	<0.02	<30	<0.02	<220	<0.02	<30	<0.02
Heptachlor	<330	<0.03	<50	<0.03	<330	<0.03	<40	<0.03
Heptachlor epoxide	<330	<0.03	<50	<0.03	<330	<0.03	<40	<0.03
Methoxychlor	<330	<0.03	<50	<0.03	<330	<0.03	<40	<0.03
Toxaphene	<1100	<0.10	<150	<0.10	<1100	<0.10	<130	<0.10

Pesticides	BCLDF 11 Soil Oxidized ug/kg	BCLDF 11 Leachate Oxidized ug/l	BCLDF 3 Soil Reduced ug/kg	BCLDF 3 Leachate Reduced ug/l	BCLDF 10 Soil Oxidized ug/kg	BCLDF 10 Leachate Oxidized ug/l	BCLDF 4 Soil Reduced ug/kg	BCLDF 4 Leachate Reduced ug/l
4,4'-DDD	<23	<0.02	<30	<0.02	<23	<0.02	<30	<0.02
4,4'-DDE	<33	<0.03	<40	<0.03	<33	<0.03	<40	<0.03
4,4-DDT	<33	<0.03	<40	<0.03	<33	<0.03	<40	<0.03
Aldrin	<23	<0.02	<30	<0.02	<23	<0.02	<30	<0.02
alpha-BHC	<23	<0.02	<30	<0.02	<23	<0.02	<30	<0.02
beta-BHC	<23	<0.02	<30	<0.02	<23	<0.02	<30	<0.02
Chlordane	<110	<0.10	<130	<0.10	<110	490	<130	<0.10
delta-BHC	<23	<0.02	<30	<0.02	<23	<0.02	<30	<0.02
Dieldrin	<23	<0.02	<30	<0.02	<23	<0.02	<30	<0.02
Endosulfan I	<33	<0.03	<40	<0.03	<33	<0.03	<40	<0.03
Endosulfan II	<33	<0.03	<40	<0.03	<33	<0.03	<40	<0.03
Endosulfan sulfate	<33	<0.03	<40	<0.03	<33	<0.03	<40	<0.03
Endrin	<58	<0.05	<66	<0.05	<58	<0.05	<66	<0.05
Endrin aldehyde	<58	<0.05	<66	<0.05	<58	<0.05	<66	<0.05
gamma-BHC (Lindane)	<23	<0.02	<30	<0.02	<23	<0.02	<30	<0.02
Heptachlor	<33	<0.03	<40	<0.03	<33	<0.03	<40	<0.03
Heptachlor epoxide	<33	<0.03	<40	<0.03	<33	<0.03	<40	<0.03
Methoxychlor	<33	<0.03	<40	<0.03	<33	<0.03	<40	<0.03
Toxaphene	<110	<0.10	<130	<0.10	<110	<0.10	<130	<0.10

LORAIN CDF 1999 PESTICIDES SOILS DATA

Pesticides	BCLDF 12 Soil Oxidized ug/kg	BCLDF 12 Leachate Oxidized ug/l	BCLDF 5 Soil Reduced ug/kg	BCDF 5 Leachate Reduced ug/l	BCLDF X Soil Oxidized ug/kg	BCLDF X Leachate Oxidized ug/l	BCLDF 6 Soil Reduced ug/kg	BCLDF 6 Leachate Reduced ug/l
4,4'-DDD	<22	<0.02	<30	<0.02	---	---	<30	<0.02
4,4'-DDE	<33	<0.03	<40	<0.03	---	---	<40	<0.03
4,4-DDT	<33	<0.03	<40	<0.03	---	---	<40	<0.03
Aldrin	<22	<0.02	<30	<0.02	---	---	<30	<0.02
alpha-BHC	<22	<0.02	<30	<0.02	---	---	<30	<0.02
beta-BHC	<22	<0.02	<30	<0.02	---	---	<30	<0.02
Chlordane	<110	<0.10	<130	<0.10	---	---	<130	<0.10
delta-BHC	<22	<0.02	<30	<0.02	---	---	<30	<0.02
Dieldrin	<22	<0.02	<30	<0.02	---	---	<30	<0.02
Endosulfan I	<33	<0.03	<40	<0.03	---	---	<40	<0.03
Endosulfan II	<33	<0.03	<40	<0.03	---	---	<40	<0.03
Endosulfan sulfate	<33	<0.03	<40	<0.03	---	---	<40	<0.03
Endrin	<56	<0.05	<66	<0.05	---	---	<66	<0.05
Endrin aldehyde	<56	<0.05	<66	<0.05	---	---	<66	<0.05
gamma-BHC (Lindane)	<22	<0.02	<30	<0.02	---	---	<30	<0.02
Heptachlor	<33	<0.03	<40	<0.03	---	---	<40	<0.03
Heptachlor epoxide	<33	<0.03	<40	<0.03	---	---	<40	<0.03
Methoxychlor	<33	<0.03	<40	<0.03	---	---	<40	<0.03
Toxaphene	<110	<0.10	<130	<0.10	---	---	<130	<0.10

Pesticides	BCLDF 13 Soil Oxidized ug/kg	BCLDF 13 Leachate Oxidized ug/l	BCLDF 7 Soil Reduced ug/kg	BCLDF 7 Leachate Reduced ug/l
4,4'-DDD	<20	<0.02	<30	<0.02
4,4'-DDE	<30	<0.03	<40	<0.03
4,4-DDT	<30	<0.03	<40	<0.03
Aldrin	<20	<0.02	<30	<0.02
alpha-BHC	<20	<0.02	<30	<0.02
beta-BHC	<20	<0.02	<30	<0.02
Chlordane	<100	<0.10	<130	<0.10
delta-BHC	<20	<0.02	<30	<0.02
Dieldrin	<20	<0.02	<30	<0.02
Endosulfan I	<30	<0.03	<40	<0.03
Endosulfan II	<30	<0.03	<40	<0.03
Endosulfan sulfate	<30	<0.03	<40	<0.03
Endrin	<50	<0.05	<66	<0.05
Endrin aldehyde	<50	<0.05	<66	<0.05
gamma-BHC (Lindane)	<20	<0.02	<30	<0.02
Heptachlor	<30	<0.03	<40	<0.03
Heptachlor epoxide	<30	<0.03	<40	<0.03
Methoxychlor	<30	<0.03	<40	<0.03
Toxaphene	<10	<0.10	<130	<0.10

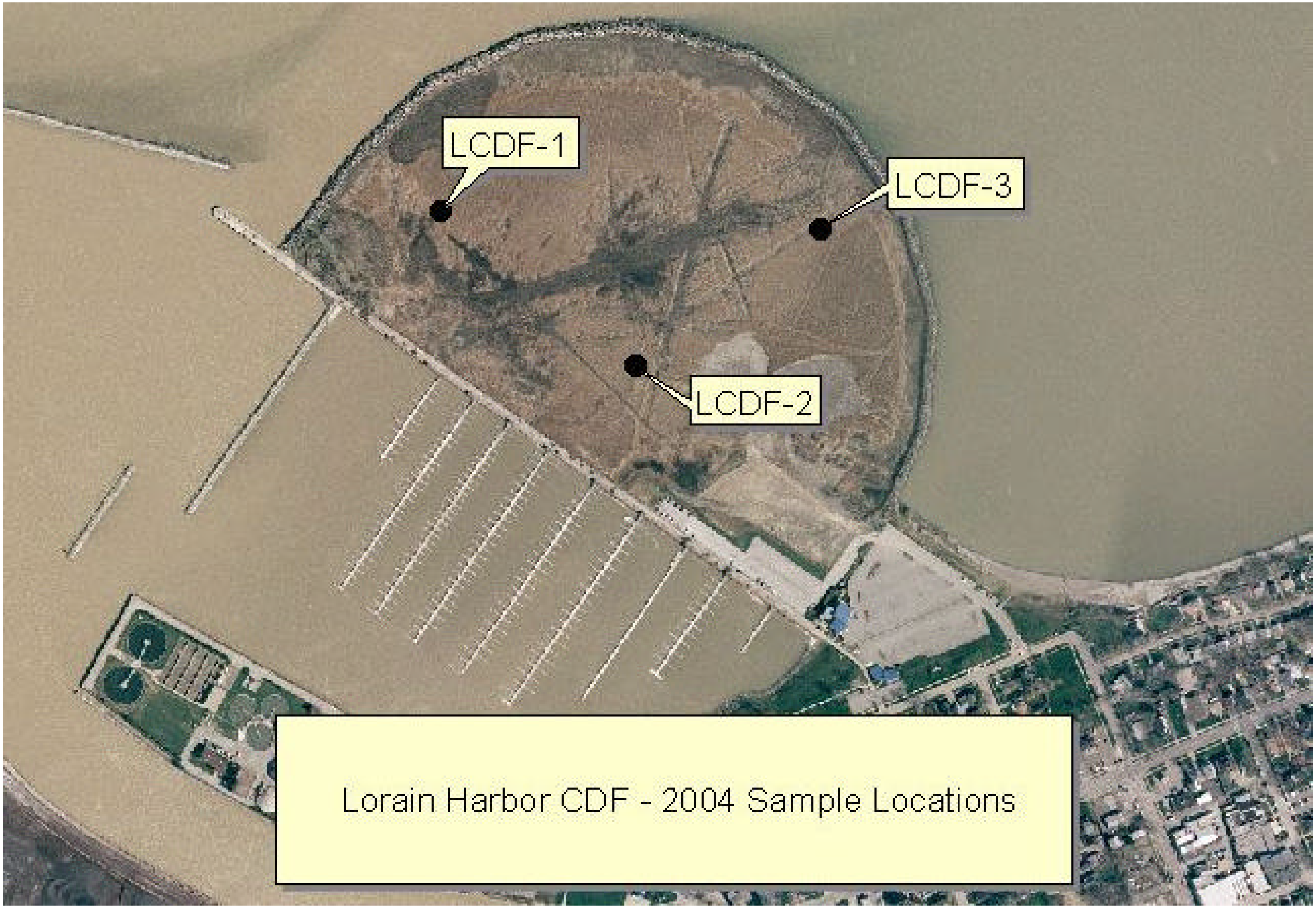
LORAIN CDF 1999 Outside Dike Water Data

Pesticides	BCLDF 20W Water ug/l	BCLDF 21W Water ug/l	BCLDF 23W Water ug/l	BCLDF 24W Water ug/l	BCLDF 25W Water ug/l	BCLDF 27W Water ug/l	BCLDF 32W Water ug/l
4,4'-DDD	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
4,4'-DDE	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
4,4-DDT	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Aldrin	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
alpha-BHC	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
beta-BHC	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chlordane	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
delta-BHC	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dieldrin	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Endosulfan I	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Endosulfan II	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Endosulfan sulfate	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Endrin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Endrin aldehyde	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
gamma-BHC (Lindane)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Heptachlor	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Heptachlor epoxide	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Methoxychlor	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Toxaphene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

LORAIN CDF 1999 PESTICIDES BACKGROUND LAKE WATER DATA

Pesticides	BCLDF 19W Water ug/l	BCLDF 22W Water ug/l	BCLDF 26W Water ug/l
4,4'-DDD	<0.02	<0.02	<0.02
4,4'-DDE	<0.03	<0.03	<0.03
4,4-DDT	<0.03	<0.03	<0.03
Aldrin	<0.02	<0.02	<0.02
alpha-BHC	<0.02	<0.02	<0.02
beta-BHC	<0.02	<0.02	<0.02
Chlordane	<0.10	<0.10	<0.10
delta-BHC	<0.02	<0.02	<0.02
Dieldrin	<0.02	<0.02	<0.02
Endosulfan I	<0.03	<0.03	<0.03
Endosulfan II	<0.03	<0.03	<0.03
Endosulfan sulfate	<0.03	<0.03	<0.03
Endrin	<0.05	<0.05	<0.05
Endrin aldehyde	<0.05	<0.05	<0.05
gamma-BHC (Lindane)	<0.02	<0.02	<0.02
Heptachlor	<0.03	<0.03	<0.03
Heptachlor epoxide	<0.03	<0.03	<0.03
Methoxychlor	<0.03	<0.03	<0.03
Toxaphene	<0.10	<0.10	<0.10

APPENDIX B Summary tables of 2004 sampling results


LCDF-1
LCDF-3
LCDF-2
Lorain Harbor CDF - 2004 Sample Locations

LORAIN CDF

2004

B/N/A SOILS DATA

B/N/A	LCDF-1 Soil ug/kg	LCDF-2 Soil ug/l	LCDF-3 Soil ug/kg
1,2,4-Trichlorobenzene	<19.1	<20.2	<21.2
1,2-Dichlorobenzene	<15.1	<15.9	<16.7
1,2-Diphenylhydrazine	<39.2	<41.4	<43.5
1,3-Dichlorobenzene	<17.1	<18.1	<19.0
1,4-Dichlorobenzene	<23.6	<25.0	<26.2
2,4,6-Trichlorophenol	<41.2	<43.5	<45.7
2,4-Dichlorophenol	<31.1	<32.9	<34.6
2,4-Dimethylphenol	<251	<265	<279
2,4-Dinitrophenol	<251	<265	<279
2,4-Dinitrotoluene	<38.2	<40.4	<42.4
2,6-Dinitrotolune	<50.2	<53.1	<55.8
2-Chloronaphthalene	<20.6	<21.8	<22.9
2-Chlorophenol	<23.1	<24.4	<25.7
2-Methyl-4,6-dinitrophenol	<251	<265	<279
2-Nitrophenol	<25.6	<27.1	<28.5
3,3'-Dichlorobenzidine	<251	<265	<279
4-Bromophenylphenylether	<51.2	<54.2	<56.9
4-Chloro-3-methylphenol	<251	<265	<279
4-Chlorophenylphenylether	<29.6	<31.3	<32.9
4-Nitrophenol	<251	<265	<279
Acenaphthene	14.7	<12.7	<13.4
Acenaphthylene	<25.1	<26.5	<27.9
Anthracene	34.4	<26.5	<27.9
Benzidine	<251	<265	<279
Benzo(a)anthracene	157	62.3	<27.9
Benzo(a)pyrene	268	182	155
Benzo(b)fluoranthene	285	123	40.4
Benzo(ghi)perylene	245	152	117
Benzo(k)fluoranthene	<25.1	<26.5	<27.9
Butylbenzylphthalate	<43.2	<45.7	<48.0

LORAIN CDF
2004
B/N/A SOILS DATA

B/N/As	LCDF-1 Soil ug/kg	LCDF-2 Soil ug/l	LCDF-3 Soil ug/kg
Chrysene	172	81.1	<27.9
Di-n-butylphthalate	<36.2	<38.2	<40.2
Di-n-octylphthalate	<45.7	<48.3	<50.8
Dibenzo(a,h)anthracene	<25.1	<26.5	<27.9
Diethylphthalate	<26.6	<28.1	<29.6
Dimethylphthalate	<27.6	<29.2	<30.7
Diphenylamine	<33.7	<35.6	<37.4
Fluoranthene	242	127	45.2
Fluorene	20.1	9.00	<6.69
Hexachlorobenzene	<30.1	<31.9	<33.5
Hexachlorobutadiene	<19.1	<20.2	<21.2
Hexachlorocyclopentadiene	<251	<265	<279
Hexachloroethane	<33.2	<35.0	<36.8
Indeno(1,2,3-cd)pyrene	254	184	159
Isophorone	<24.1	<25.5	<26.8
N-Nitrosodipropylamine	<34.2	<36.1	<37.9
Naphthalene	80.1	<26.5	<27.9
Nitrobenzene	<30.6	<32.4	<34.0
Pentachlorophenol	<251	<265	<279
Phenanthrene	129	56.2	<27.9
Phenol	<19.1	<20.2	<21.2
Pyrene	179	99.5	35.0
bis(2-Chloroethoxy)methane	<18.6	<19.6	<20.6
bis(2-Chloroethyl)ether	<56.3	<59.5	<62.5
bis(2-Chloroisopropyl)ether	<16.6	<17.5	<18.4
bis(2-Ethylhexyl)phthalate	474	146	109

LORAIN CDF
2004
TOTAL ORGANIC CARBON SOILS DATA

Total Organic Carbon mg/kg	LCDF-1 Soil	LCDF-2 Soil	LCDF-3 Soil
	31,800	26,600	27,500

LORAIN CDF
2004
TOTAL CYANIDE SOILS DATA

Total Cyanide ug/kg	LCDF-1 Soil	LCDF-2 Soil	LCDF-3 Soil
	829	439	420

LORAIN CDF
2004
DIOXIN SOILS DATA

2,3,7,8-TCDD pg/g	LCDF-1 Sediment
	0.722